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MASTER THESIS

ŽALIASIS FINANSAVIMAS IR DARNUS VYSTYMASIS BALTIJOS JŪROS REGIONO ŠALYSE	GREEN FINANCE AND SUSTAINABLE DEVELOPMENT IN BALTIC SEA REGION COUNTRIES
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INTRODUCTION

Green finance and sustainable development topics have emerged rapidly since the introduction of the 2030 Agenda for Sustainable Development. This is related to the fact that the environmental goals of the 2030 Agenda are financed using green funds. To tackle climate change, ensure access to affordable and clean energy for people worldwide, combat desertification, and sustainably manage forests, green funding is essential. Another important aspect is that companies are increasingly incorporating environmental, sustainability, and governance topics into their daily discussions and annual reports. This confirms that these issues are becoming crucial not only at the political level but also at the corporate level.

Nevertheless, there are uncertainties surrounding green funds – such as what requirements must be met to obtain them, whether the cost of debt is higher or lower for green finance instruments, how to attract investors to green finance projects, and what the strengths and weaknesses of green finance are. These uncertainties contribute to the struggle companies face in attracting green investments through debt instruments such as bonds and loans, or equity instruments.

Despite the fact that sustainable development goals are on the agendas of more than 190 countries worldwide, this does not mean that attracting green funds is easier. For countries in the Baltic Sea Region – Lithuania, Latvia, Estonia, Finland, Sweden, Denmark, Germany, and Poland – it should be easier to attract funds, as these countries are part of the European Union, which introduced the Green Deal in 2021 with the goal of becoming a climate-neutral continent by 2050. However, this is not necessarily the case. Therefore, this paper will analyze how green finance and sustainable development are evolving in the Baltic Sea Region countries.

The relevance of the topic

The relevance of this topic is primarily tied to the 2030 Agenda for Sustainable Development. In 2015, 193 countries signed this document, and the Baltic Sea Region countries are part of it. Additionally, the European Green Deal significantly impacts the relevance of this topic. All 27 European Union countries have signed this agreement and committed to making Europe the first climate-neutral continent by 2050. However, this goal will not be achievable without green funding, as green finance is essential for addressing environmental challenges.

The level of exploration of the topic

The exploration of green finance and sustainable development in Baltic Sea Region countries is limited. However, Gharleghi et al. (2024) conducted research on green bonds and their influence on sustainability, with a focus on Germany and European Union countries, while Primic et al. (2024) investigated whether green policies reduce greenhouse gas emissions in European Union countries. Nevertheless, other authors have explored green finance and sustainable development separately,

leading to the discovery of various definitions of green finance (Gharleghi et al., 2024, Huang et al., 2023, Bhatnagar and Sharma, 2022). ICMA (2021) contributed to the analysis of green bonds and green loans, while Lin (2022) focused on green venture capital firms.

Through different scientific articles, the main strengths and weaknesses have been analyzed, based on research by Omri et al. (2025), Muganyi et al. (2021), Tand and Zhang (2020), and others. The sustainable development topic was mainly analyzed through 10,000 articles from Web of Science, which helped systematically summarize the level of different topics explored in scientific research by creating respective clusters.

The novelty of the work

The novelty of this thesis lies in its focus on green finance and sustainable development in the Baltic Sea Region countries. Although there is existing research related to individual countries within the Baltic Sea Region, mainly Germany (Gharleghi et al. (2024)), or at the European Union level (Primic et al. (2024)), it remains difficult to comprehensively evaluate green finance and sustainable development across the Baltic Sea Region as a whole. Due to the lack of sufficient scientific research on this topic, this thesis contributes by providing a systematic evaluation of green finance and sustainable development in the Baltic Sea Region countries.

The problem – despite the growing role of green finance in promoting sustainable development, how does green finance influence the environmental, social, and institutional dimensions of sustainable development in Baltic Sea Region countries?

The aim – to analyze the role of green finance in shaping environmental, social, and institutional outcomes of sustainable development in Baltic Sea Region countries using an empirical panel-data approach.

The objectives:

1. Perform a thorough review of scientific literature and systematize the main objectives of green finance and sustainable development.
2. Develop a methodology which would allow for the analysis of green finance and sustainable development in Baltic Sea Region countries.
3. Conduct the study based on the developed methodology; analyze the results and present empirical evidence. Additionally, draw conclusions from the findings, address the limitations, and offer suggestions for future research.

The methods deployed by the Master thesis – the literature review is conducted using systematic reviews and the VOSviewer system. The systematic review of the literature helped to present the main aspects of green finance relevant to this thesis, while the literature review using the VOSviewer system allowed for the presentation of key topics in the field of sustainable development.

Based on the literature review, the most appropriate methods for assessing green finance and sustainable development in the Baltic Sea Region countries include Ordinary Least Squares, Fixed-Effects, and Random-Effects regression models. In addition, the Variance Inflation Factor, the Breusch–Pagan Lagrange Multiplier test, and the Hausman test will be performed.

The structure of the master’s thesis is organized as follows. Section one provides a literature review on green finance, including definitions, green finance instruments, benefits and drawbacks, and key actors in the system. In the sustainable development section, scientific articles are analyzed, and the main topics of sustainable development are presented. Additionally, the main findings related to this topic in the Baltic Sea Region countries are introduced. Section two describes the development of hypotheses and outlines the methodologies used to address the key research questions. In Section three, an empirical study is conducted following the proposed methodology using the R software environment, and the principal findings are subsequently presented and analyzed.

1. LITERATURE REVIEW OF GREEN FINANCE AND SUSTAINABLE DEVELOPMENT

The concept of green finance and sustainable development emerged in 2015, following adoption of the Paris Agreement and the 2030 agenda for sustainable development at the United Nations Climate Change Conference. Although the first green bonds were issued in 2007 by the European Investment Bank, Bhatnagar and Sharma (2022) argue that the concept of green finance was first used in the late 1980s in the book “The Blueprint of Green Economy”. Therefore, some time has passed since the major players in financial markets began to discuss it in more detail (World Bank, 2019). Nevertheless, there is no single, universally accepted definition of green finance. As a result, this paper will present multiple definitions, as well as discuss the financial instruments of green finance, the main parties involved, and its benefits and drawbacks. A deep look into sustainable development will be taken from a scientific research perspective, focusing on the main topics in scientific literature and how they are related.

1.1. Definition of Green Finance

When discussing green finance, the majority of authors agree that it is still an evolving topic, and different scholars define it in various ways. The definitions presented in Table 1 will help to clarify what green finance is.

Table 1

Definitions of Green Finance

Author	Definition
World Economic Forum (2020)	Green finance is any structured financial activity that has been created to ensure a better environmental outcome.
Gharlegghi et al. (2024)	Green finance is green growth and transition to a green economy while reducing the negative environmental impacts.
Huang et al. (2023)	Green finance supports sustainable businesses to improve environmental performance, climate mitigation, and resource conservation.
Bhatnagar and Sharma (2022)	Green finance is the intersection of the financial industry, environment protection and economic growth.

Continuation of Table 1

Soundarrajan and Vivek (2016)	Green finance is a strategic approach to incorporate the financial system to aim towards low-carbon and resource-efficient economies.
Lindenberg (2014)	Financial investments flowing into sustainable development projects and initiatives, environmental products, and policies that encourage the development of a more sustainable economy. Green finance includes climate finance but is not limited to it. It also refers to a wider range of other environmental objectives, such as industrial pollution control, water sanitation or biodiversity protection.

Source: table constructed by the author.

Analyzing Table 1, it is clear that the word environmental appears in almost all definitions. This highlights the fact that one of the primary goals of green finance is to address the impact of climate change, including projects related to renewable energy, pollution prevention and control, biodiversity conservation, sustainable use of natural resources, and circular economy activities. Since the environmental aspect is a core feature of green finance, it can be said that green finance is part of the environmental component of the Environmental, Social, and Governance (ESG) investing framework. According to the European Commission (2024), environmental considerations can include the already mentioned circular economy, preservation of biodiversity, and pollution prevention. Social considerations take into account issues such as inequality, inclusiveness, labor relations (including investment in workers' skills), and human rights. Regarding the governance aspect, it considers management structures, employee relations, and executive remuneration, but most significantly, it ensures that social and environmental considerations are integrated into the decision-making process. Therefore, funds used to finance all three ESG components, either individually or in combination, are described as sustainable finance funds (Liang and Zhang, 2025). This means that green finance is a part of sustainable development, which will be discussed in detail later.

To sum up, the definition of green finance is still evolving, but majority of definitions include the word environment, which helps to determine that green finance is the main type of funding that supports efforts to address environmental issues such as climate change, pollution prevention, and the circular economy.

1.2. Green Finance Instruments

There is a wide variety of green finance instruments used to finance environmental issues. For example, green bonds, green loans, green mutual funds, and green venture capital funds are some of the most common types of green finance instruments. However, as mentioned in the section above, since the definition of green finance is still evolving, the types of instruments are also still developing.

One of the most popular and effective green finance instruments is green bonds. According to Tang and Zhang (2020), green bonds are financial instruments aimed at improving environmental impact and social welfare, such as reducing CO₂ emissions, preventing pollution, enhancing renewable energy, promoting sustainable water management, or supporting climate change adaptation. The authors highlight that the proceeds are used for green projects, however, the bonds are backed by the issuer's entire balance sheet. Reboredo (2018) notes that green bonds are fixed-income financial instruments similar to conventional bonds in terms of pricing and rating. However, the main difference is that the proceeds are earmarked by the issuer for projects with environmental benefits. The author also mentions that the International Capital Markets Association (ICMA) published the Green Bond Principles in January 2014, which help to determine whether a bond can be considered green. The main four components are (International Capital Markets Association, 2021):

1. Use of Proceeds;
2. Process for Project Evaluation and Selection;
3. Management of Proceeds;
4. Reporting.

The first component, use of proceeds, is the most significant because it distinguishes green bonds from conventional bonds, as described above. However, ICMA notes that the proceeds should be clearly outlined in the legal documentation and must provide environmental benefits, which should be assessed using quantitative methodologies where appropriate. There are several broad categories of eligibility for green projects: climate change mitigation and adaptation, natural resource and biodiversity conservation, and pollution prevention and control. Renewable energy may include production, transmission, appliances, and other products, while energy efficiency projects can cover new and refurbished buildings, energy storage, and district heating. This means that green bonds could be used to improve the living conditions of current households. Pollution prevention could include the reduction of air emissions, greenhouse gas control, waste management (in terms of reduction and recycling), and, as ICMA (2021) notes, proceeds from green bonds can be used for climate-smart farm inputs, environmentally sustainable forestry, protection of coastal and marine ecosystems, clean transportation, and more.

The second component is the process for project evaluation and selection. ICMA (2021) clearly states that the issuer needs to provide a clear explanation to investors of how the environmental sustainability objectives support green projects and that the proceeds will be used exclusively to finance green projects. Moreover, the issuer should provide information on the processes through which social and environmental risks are associated with the relevant projects. These three aspects are mandatory, nevertheless, investors are highly encouraged to provide information on official or market-based taxonomies, related eligibility criteria, and any green standards or certifications that are relevant in project selection (ICMA, 2021).

The third component is the management of proceeds, which primarily focuses on the outstanding amount of a green bond and ensures that proceeds are periodically adjusted to match allocations to eligible green projects. If there are unallocated net proceeds, the issuer should inform investors of the intended types of temporary placements. It is worth noting that proceeds can be managed not only per bond but also on an aggregate basis for multiple green bonds, which would be similar to a portfolio approach. It is highly recommended that a third party, such as an external auditor, verify the allocation of funds to ensure a high level of transparency (ICMA, 2021).

Finally, the fourth principle is reporting. According to ICMA (2021), issuers should keep information about the use of proceeds available and up to date for investors, and this information needs to be renewed annually or, in the case of significant events, updated on a timely basis. The annual report should include a list of projects funded by the proceeds, along with a brief description of the relevant projects, amounts allocated, and their expected impact. In this component, both qualitative and quantitative performance indicators are important. It is recommended that issuers adopt the guidance and impact reporting templates used in the Harmonised Framework for Impact Reporting. An example is provided in Table 2.

Table 2

Illustrative Summary Template for Reporting on Green Portfolios/Projects

Eligible Green project category	Sustainable Water & Wastewater Management
Sub Category	Sustainable Water Management
Project or Portfolio name	Project A/Portfolio A
Signed amount	Currency
Share of total project or Share of Total portfolio financing	%

Continuation of Table 2

Eligibility for Green Bonds	% of signed amount
Green project category component	% of signed amount
Allocated amount	Currency
Project or Average Portfolio Lifetime	In years
Core Indicator #1	Annual absolute (gross) amount of wastewater reused as %

Source: table constructed by the author.

Table 2 illustrates how the main information can be presented to investors. However, the issuer should consider all core indicators provided in the Harmonised Framework for Impact Reporting (2024). For example, for the sustainable water and wastewater management project category, it is highly recommended to provide annual absolute (gross) water use before and after the project, measured in m³/a, along with the reduction in water use as a percentage. In the case of water treatment projects, it is recommended to provide the annual absolute (gross) amount of wastewater treated, reused, or avoided before and after the project, measured in m³/a and p.e./a, as well as the percentage reduction (ICMA, 2024).

Therefore, green bonds are the most established green finance instrument, with clear guidance from ICMA. It can be said that this clear guidance is one of the main reasons why investors are most likely to invest in green bonds, compared to other types of green investments. Nevertheless, Tang and Zhang (2020) also state that issuers' stock prices increase around the announcement of green bond issuance, which leads to improved stock liquidity. Additionally, it attracts more media attention, which can be used to attract new investors.

Another debt instrument is green loans. According to the World Bank (2021), a green loan is a type of financing that allows borrowers to use the proceeds to fund projects that make a significant contribution to an environmental objective. Wang et al. (2024) notes that green loans are financed by the bank's own funds, residents' savings, and government taxes with the goal of improving borrowers' energy efficiency. Tommaso et al. (2025) concludes that these loans provide financing for initiatives that improve environmental outcomes, advance climate change mitigation, and promote sustainable development, while the primary goal of green loans is to direct funding toward activities that generate positive environmental outcomes, supporting the shift to a low-carbon and more sustainable economy.

ICMA has established principles not only for green bonds but also for green loans. The four main principles are the same as those already described in the green bonds section and are very similar, however, the main differences lie in the use of proceeds. Specifically, a green loan may have

one or more tranches of a loan facility. In this case, ICMA (2021) highlights the importance of a clearly designated account where different tranches would be credited and tracked by the borrower in an appropriate manner. Similarly to green bonds, the borrower of a green loan should clearly communicate to lenders the following information: what environmental objectives the borrower wants to achieve, the process that would demonstrate how projects can be considered green, and the related eligibility criteria, which could include exclusion criteria or any other process applied to identify and manage potentially material environmental risks (ICMA, 2021). Lee et al. (2025) concludes that green loan borrowers should enhance information-sharing mechanisms among financial institutions, regulatory bodies, and environmental protection agencies. They should also ensure the timely and accurate disclosure of environmental review information pertaining to relevant enterprises, thereby improving the overall availability of reliable data. Such measures would provide commercial banks with essential reference points when extending green credit, reduce the auditing costs associated with green credit operations, and mitigate potential environmental and credit risks stemming from information asymmetry (Lee et al., 2025). The third principle is management of proceeds, which aims to ensure that proceeds are credited to a dedicated account for transparency. It is also highly encouraged to establish an internal governance process through which the allocation of funds can be tracked. Finally, the reporting aspect is very similar to the green bonds reporting component, but ICMA (2021) adds that borrowers with the ability to monitor achieved impacts are encouraged to include these in regular reports.

One type of green loan could be a revolving credit facility. If a company uses this type of instrument, it should follow the list of eligible categories throughout the lifetime of the revolving credit facility, such as renewable energy, pollution prevention and control, or climate change adaptation. It is noted that a revolver can include a specific green tranche, but if this is not possible, the borrower can report the use of any revolver borrowing when green assets are supported by the facility. It is also worth mentioning that revolving credit facilities for general purposes should not be treated as green unless they satisfy the four main components described above (ICMA, 2021). Nevertheless, Sobiech, A. L. & Uchida, H. (2025) conclude that the use of green loans is positively linked to a firm's financial health. Firms that use green loans tend to have stronger credit ratings, higher sales growth, and lower leverage than firms that do not. These characteristics typically associated with large, publicly listed borrowers in the finance literature, which means that for these types of companies it is easier to get revolving credit facilities or comply with ICMA principles.

Another important aspect of green loans is that they lower firms' borrowing costs. According to Xu and Tian (2025), this can be explained by two main mechanisms: signal transmission and risk avoidance. Signal transmission is supported by enhancing information transparency and shaping

firms' reputations. Regarding risk avoidance, the authors explain that firms mitigate compliance and financial risks, which leads to a positive impact on lower-cost bank loans (Xu and Tian, 2025). If a firm can use government subsidies, it can also reduce borrowing costs and increase profits, depending on the efficiency of the subsidies. This is a common practice in China, where government departments often subsidize firms that want to use green financial instruments. Wang et al. (2024) observe that when the government subsidizes firms' green loans, the cost gradually decreases. Tommaso et al. (2025) says that banks may provide better conditions, such as lower interest rates or longer repayment periods. Green loans offer banks a chance to promote sustainability and bolster their reputation for social responsibility, but they also come with specific risks that require careful oversight. Therefore, banks must carefully assess the creditworthiness of borrowers and the particular risks associated with green projects.

Taking everything into consideration, green loans are similar to green bonds not only because both are debt instruments, but also because ICMA has established common standards for both types of debt. Nevertheless, bonds are usually larger than loans in terms of scale, meaning that projects funded by loans tend to be smaller. However, green loans have the advantage of lower interest rates.

Green finance indices, such as the Dow Jones Sustainability World Index (SUS), the S&P Green Bonds Index (GB), and the S&P 500 ESG Index (ESG), are also considered green finance instruments. The SUS consists of the top 10% of the largest 2,500 companies in the S&P Global BMI, based on long-term ESG criteria. The GB Index includes only bonds whose proceeds are used to fund environmentally beneficial projects, while the ESG Index is a market-cap-weighted index that considers the performance of stocks meeting sustainability standards, while maintaining the same overall industry group weights as the S&P 500 (Zeng et al., 2025). According to Arribas et al. (2021), sustainable stock indices were developed as standards for sustainable finance instruments, such as mutual or pension funds. The authors explain that there are established social rating agencies that evaluate corporate ESG behavior based on their methodologies and, after evaluation, select which stocks can be included in sustainable stock indices (Arribas et al., 2021). It is worth mentioning other vital indices, such as the NASDAQ OMX Green Economy Index (GE Index), which is a market-capitalization-weighted index representing companies mainly from industries related to sustainable development. Another example is the MSCI World Environmental, Social & Governance Leaders Index (ESG Index), which is also a market-capitalization-weighted index representing firms in 23 developed markets. On the other hand, the MSCI Global Environment Index (GENV Index) consists of securities from companies that generate at least 50% of their revenues from environmentally beneficial products or services. From an investor's point of view, it provides the option to invest in companies whose primary source of revenue is related to green projects (Šević et al., 2024).

Venture capital is still an emerging topic in the field of green finance, however, it is clear that institutional investors are increasingly considering green investments. Yu et al. (2024) describe venture capital as a compatible financial mechanism for catalyzing corporate green innovation, through equity investments and strategic support, including capital infusion, human resources, and rigorous oversight. Randjelovic et al. (2003) proposed a definition of green venture capital as high-risk financial capital provided to eco-innovative ventures, offering the potential for financial returns while contributing to sustainable development. Mrkajic et al. (2019) note that green high-tech ventures usually have significant managerial slack in the initial stage of the sector. These ventures are highly capital-intensive, and green tech companies typically have greater technological complexity compared to non-green high-tech ventures. Moreover, they face lower exit opportunities through IPOs or M&As, as the industry is relatively new and lacks a proven framework for evaluating green-tech potential. Mrkajic et al. (2019) highlight that the market is highly regulated and fraught with uncertainty due to unstable prices of natural resources. Talking about uncertainty, Lin (2022) states that venture capital provides strong and unique investor protection mechanisms, which are essential in the emerging green finance space, because venture capital investments typically involve monitoring and contractual mechanisms to protect against information asymmetry. Since venture capital is usually supported by institutional investors, there are three main stages: the fund-raising stage, the investment stage, and the exit stage. According to Lin (2022), in the first stage, venture capitalists face issues related to green financing, such as the differing maturities of green or sustainable funds compared to traditional funds, the higher illiquidity of green funds, and the limited exit possibilities. Nevertheless, if venture capitalists were to amend strict contractual terms, there is a possibility that these funds would become more attractive to investors, making it easier to raise capital. Moreover, governments could have a positive impact by amending regulations in favor of institutional investors. In the second, or investment stage, Lin (2022) suggests that greater comparability in disclosures is required. Investors would need more information about whether an investment can be classified as green and why. In the final stage, the exit stage, not only venture capitalists but also companies would need to educate investors more about green portfolio companies and the urgency of sustainability issues, which could lead to successful exit opportunities for green venture capital funds. In summary, venture capital is an equity-type investment primarily related to institutional investors and is associated with higher risk since it typically invests in early-stage technological companies.

Taking everything into consideration, green finance instruments are a significant measure for tackling climate change and other environmental issues. On the one hand, there are debt instruments such as bonds and loans, on the other hand, there are equity instruments, such as indices and venture

capital investments. The most popular green finance instrument is bonds, nevertheless, other instruments are also finding their place in the finance world. However, all relevant parties need to devote more time to educating people about green finance instruments and why investors should consider investing in them. For this reason, the benefits and drawbacks of green finance should be analyzed.

1.3. Strengths and Weaknesses of Green Finance

Before making investment decisions, people usually conduct careful analysis of specific financial instruments. Green finance, as an investment field, is no exception, therefore, it is relevant to understand its advantages and disadvantages. Table 3 summarizes the benefits and drawbacks of green finance, which will be explained in this paper.

Table 3

Summary of Strengths and Weaknesses of Green Finance

Strengths	Weaknesses
FinTech inclusion	Greenwashing
Positive impact on company's name	Lack of stable policies
High ESG score reduces cost of debt	Constraints on decision making within investor companies
Promotes foreign direct investment	Absence of appropriate financial vehicles/instruments
Increases employment	High transaction costs or fees

Source: table constructed by the author based on Omri et al. (2025), Tang & Zang (2020), Wang (2024), Ratajczak and Mikolajewicz (2021), Eliwa et. al (2021), (Liu et al., 2024), Ge and Zhi (2016), Fu et al. (2025), Wang et al., (2025), Keilmann and Koch (2024), Kraeussl et al. (2023), Qiu et al., (2020), Hafner et al. (2020).

The first strength would be the expansion of FinTech. According to Omri et al. (2025), the synergy between FinTech and green finance is vital because it enhances the accessibility, transparency, and effectiveness of green finance. Muganyi et al. (2021) add that FinTech can increase investors' confidence and trust in green finance, which would help attract more investments in environmentally related projects. FinTech innovations, such as crowdfunding platforms, can help involve not only institutional investors but also smaller investors in green finance, as they provide more opportunities to attract funds and contribute to sustainable development goals (Morgan, 2022). The second benefit would be the positive impact on a company's name. Based on the research by

Tang and Zhang (2020), stock prices increase significantly around the announcement of green bond issuance, while Wang (2024) found that the use of green finance improves the quality of accounting information and reduces a firm's financial constraints, which boosts corporate goodwill due to external profit pressure, the implementation of green finance policies, and an increase in the standards set by certain regulatory bodies. The third advantage would be the reduction of the cost of debt. According to Ratajczak and Mikolajewicz (2021), corporate social responsibility related to environmental factors decreases the cost of long-term debt. Eliwa et. al (2021) confirm this finding, noting that lending institutions take into account ESG performance and disclosure by integrating them into their final credit decisions. This means that lending institutions play an essential role in improving ESG performance and disclosure. Nevertheless, the authors highlight that ESG disclosure can be substituted for ESG performance, which means there is no clear distinction between ESG disclosure and performance. Furthermore, green finance can promote foreign direct investment. Companies that issue green bonds or loans need to comply with specific policies, which increases compliance and governance practices within the firm, strengthening their legitimacy and competitiveness compared to companies that do not have such governance policies (Liu et al., 2024). Green finance also enhances international reputation, improves risk management capabilities, adheres to international standards, and builds global green cooperation networks, all of which have a positive impact on foreign direct investment (Liu et al., 2024). Moreover, green finance can create additional jobs which could lead to a lower unemployment rate. Ge and Zhi (2016) state that new jobs are created in green technology research and development, environmental management, and renewable energy equipment manufacturing, all of which are high-paying jobs. However, traditional jobs may be displaced due to technological advancements. Moreover, it is important to mention that attracting more investments to environmental projects could create more employment opportunities in related sectors. Fu et al. (2025) conducted research on manufacturing companies in China. As is well known, manufacturing companies are among the biggest polluters, therefore, green finance investments are crucial in this sector to reduce its negative impact on the environment. The research showed that the establishment of green finance innovation and reform pilot zones increased the employment rate by approximately 10.16% compared to non-pilot zones (Fu et al., 2025). Green finance has many advantages, starting with the most important one: it helps reduce the negative impact on environmental issues. It also promotes digitalization and automation, enhances the public image of companies, reduces the cost of debt, facilitates the attraction of foreign direct investments, and can even decrease unemployment.

Talking about weaknesses, the first and the most well-known is greenwashing. According to Merriam-Webster dictionary, greenwashing is described as the act or practice of making a product, policy, activity, appear to be more environmentally friendly or less environmentally damaging than it

really is (Merriam-Webster, 2024). Greenwashing has many negative outcomes such as stakeholder distrust, regulatory compliance issues, market confusion, competitive disadvantages, and reputational risk (Wang et al., 2025). Talking about stakeholder trust, Keilmann and Koch (2024) highlight the importance of communicating the truth not only to internal stakeholders, but also to external ones, such as consumers, otherwise, it can have negative consequences on a company's credibility. Despite the fact that green finance enhances transparency, there is a mutual agreement that regulations are not yet strictly set, which could lead to operational challenges and legal consequences if the regulatory environment is not closely monitored (Wang et al., 2025). Kraeussl et al. (2023) discuss market confusion from an investor's point of view, as they may struggle to distinguish between truly sustainable actions and those that only pretend to be sustainable. This confusion could lead them to choose to invest in other financial products not related to green finance. When comparing truly sustainable companies with those that engage in greenwashing, the former may face competitive disadvantages. For example, they may lose market share due to higher product costs compared to companies that engage in greenwashing or are not environmentally friendly at all (Qiu et al., 2020). All these aspects of greenwashing lead to reputational risk, which can be considered either an additional part of greenwashing or a consequence of all the aforementioned issues. Zhang et al. (2024) relationship between firms' greenwashing levels and their subsequent stock price crash risk. Mechanism tests indicate that companies engage in greenwashing to divert external scrutiny from unfavorable information regarding their sustainability practices and managerial opportunism. Consequently, this buildup of negative information increases the firms' risk of a stock price crash in the future (Zhang et al., 2024). Greenwashing is one of the key issues in green finance, however, it is not the only one. Another critical problem is the lack of stable policies. Hafner et al. (2020) conducted a literature review and interviewed 17 individuals working as private investors, asset owners and managers, representatives of banks and pension funds, actuaries, and academic researchers with expertise in investment decisions. It was concluded that the biggest weakness of green finance is the lack of a long-term climate change policy framework and the absence of stable policies. The authors suggest that the possible solutions to address this issue include the development and establishment of a transparent, clear, consistent, and long-term policy framework, direction, and vision. They also argue that certain measures should be taken at the government level, such as the establishment of a national infrastructure strategy and roadmap with a project pipeline. Additionally, the government could assist by conducting public opinion campaigns and coalition building, although lobbying should not be overlooked, according to the research. Constraints on decision-making within investor companies is the second biggest barrier identified in the research, which is supported by short-termism in the financial system. Hafner et al. (2020) provide six possible improvements that could

ease this barrier: amendments to insurance, pension fund, and banking regulations (for example, the implementation of prudential standards to support investments in green infrastructure); adoption of a broader, internationally harmonized definition of 'fiduciary duty' that includes the duty to consider ESG values and climate risks; realigning incentive structures in the financial industry to better link compensation with the long-term sustainable performance of investments, while shifting investor practices towards sustainable, long-term investment approaches; the issuance of more green bonds or other sustainable investment instruments; direct investments, the issuance of green loans, or the implementation of other de-risking measures by the government or investment banks; and, lastly, the solution of green quantitative easing proposed by the authors. In order for these solutions to become a reality, support would be needed from government institutions, central and investment banks, investors, and financial intermediaries. Moreover, there is still a shortage of green financial instruments in the market. Hafner et al. (2020) suggest that specific financial products should be created with the aim of developing renewable energy infrastructure, such as the continuous issuance of green bonds and the establishment of new products. Not only is the lack of appropriate green financial instruments a drawback, but also the high transaction costs. The authors (2020) propose that financial system intermediaries could reduce fees and transaction costs related to green projects, such as renewable energy. This could be achieved through further cost reductions for renewable energy infrastructure investments, such as standardizing contracts, increasing aggregation, and enhancing knowledge-sharing. This is closely related to one of the advantages – FinTech inclusion – because standardization and digitalization could reduce costs. In conclusion, greenwashing is the most well-known issue in green finance, and it encompasses many different problems. However, it is not the only issue. A literature review and interviews with professionals in the finance field show that the lack of stable policies, constraints on decision-making within investment companies, the absence of green financial products, and high transaction costs are also significant problems in the green finance sector. However, these issues cannot be addressed unless government institutions, financial intermediaries, and other key stakeholders in the green finance field work together.

1.4. Green Finance Actors

Financial markets can be divided into money markets and capital markets. The main players in money markets are banks and governments, while in capital markets, the key actors are corporations, governments, and financial institutions. Furthermore, financial intermediaries and regulators should also be considered, as they play a vital role in both markets (Jurevičienė, 2016). For example, Lamperti et al. (2019) argue that there should be a distinction between public and private actors supporting green finance in the global economy. As green finance is often considered a risky investment, government involvement can help reduce this risk by providing support. Since the green

finance field is still developing within financial markets, it is important to understand its main players and how they interact within the global economy.

To begin with, government bodies such as finance ministries and other public institutions play a vital role in the green finance field. Finance ministries cannot be considered financial actors in the strict sense, as their main role is to govern the economy rather than directly engage in it, however, through regulation, grants and subsidies, ministries become a part of green finance system (Babic, 2024). By shaping regulatory frameworks, such as creating taxonomies for sustainable energy sources or offering tax incentives and other benefits for renewable energy, government bodies can encourage economic actors to increase investment in sustainable assets and activities (de Mooij et al., 2012). Finance ministries are also critical in reducing government carbon subsidies and can thus play a vital role in shifting "brown" subsidies into "green" finance. This more proactive role as providers of green finance is increasingly recognized as a key function of treasuries and ministries. This indicates a far more proactive role than merely serving as a regulatory body and underscores the growing significance of government institutions in directly supplying green finance (Babic, 2024). Furthermore, Public Development Banks are considered one of the most vital public actors in the green finance system (Marodon, 2022). Public Development Banks can serve a range of developmental functions, often at the local or regional level. A particularly significant type of Public Development Banks are Multilateral Development Banks. These are supranational financial institutions that primarily offer grants and loans for development purposes, including sustainable development. Their shareholders typically consist of both developed (non-borrowing) and developing (borrowing) countries. For example, Multilateral Development Banks can be considered The World Bank Group, the African Development Bank, and the European Bank for Reconstruction and Development. These organizations act as implementing agencies for the oldest global climate fund, the Global Environmental Facility, which attracts funds for green development projects, which are subsequently executed by one of its implementing agencies (Babic, 2024). Another significant role of Multilateral Development Banks is the public impact on decision-making. The role of Multilateral Development Banks in shaping narratives and practices around green finance is a key source of authority in the global green finance landscape. In contrast, some national Public Development Banks, such as China's largest financial institution, the China Development Bank, are significantly larger in terms of the assets they manage, nevertheless, asset volumes are not the most important thing, as the influence of China Development Bank is way smaller compared to the well-known Multilateral Development Banks (Babic, 2024).

According to Babic (2024), central banks occupy a middle-agent position between public and private actors, and in recent years, they have become increasingly influential in shaping both the

discourse and the practical framework of global green finance. Central banks have emerged as key players in the energy transition, with the growing use of green financial instruments and a reconsideration of their mandates (van't Klooster and van Tilburg, 2020). This suggests that central banks participating in money or capital markets are expected to consider factors like energy system decarbonization when carrying out these operations (Babic, 2024). Another crucial role of central banks is shaping green finance flows through regulation and supervision, such as setting reserve requirements. They influence market participants by forecasting and analyzing global financial markets and, importantly, by setting key interest rates, which can either promote or hinder the growth of green financial flows (van't Klooster, 2023). Berensmann & Lindenberg (2016) agree that certain measures should be taken by central banks to steer financial markets toward greater sustainability through the implementation of appropriate policies and regulations. For instance, the authors (2016) suggest that banking stress tests and due diligence standards for banks and financial institutions could place greater emphasis on climate risks to influence overall investment behavior. Ibrahiem et al. (2023) provide three main green instruments that can be used by central banks: green micro-prudential regulation, green macro-prudential regulation, and green financial market development. The first, green micro-prudential regulation involves integrating environmental risks into supervisory and regulatory frameworks. Furthermore, central banks may require financial institutions to disclose their vulnerability to climate-related hazards and to develop strategies for mitigating those risks. Another possible action is to offer preferential capital treatment for green investments or mandate that financial institutions maintain a specific percentage of their assets in green investments (Ibrahiem et al., 2023). Moving to green macro-prudential regulation, the authors (2023) highlight that the requirement for banks to report their exposure to climate-related risks is an example of green macro-prudential regulation. This can help investors better understand the potential opportunities and risks associated with specific investments, while also encouraging banks to take measures to mitigate these risks. Finally, green financial market development is another tool central banks can use, explained by the creation and promotion of financial markets that facilitate investments in low-carbon, green initiatives and businesses (Ibrahiem et al., 2023). Not only are these three aspects important, but also the research on climate change performed by the Bank of England and the Bank of Japan. The Federal Reserve System provides climate risk assessments and green banking rules, while the European Central Bank purchases green bonds and establishes green monetary policies (Ibrahiem et al., 2023). Taking everything into consideration, central banks play a vital role in the green financial system because they can act as regulators and participants, promoting green investments.

Moving to fully private actors, the most important ones are institutional investors and private banks. Institutional investors provide their money to asset managers, who play a crucial role in

directing and managing green financial flows on a global scale (Babic, 2024). For example, BlackRock disclosed that at the end of 2023, USD 802 billion, or 8% of total assets under management, was invested in sustainable strategies, which implies that these investments are related to green finance (BlackRock, 2023). On the other hand, it can be hard for asset managers to invest in fully green products because they usually receive funds from institutional investors. According to Berensmann and Lindenberg (2016), even if institutional investors are willing to invest in long-term and sustainable projects, existing regulations often prevent them from doing so or allow only very limited involvement, as these regulations favor cautious and conservative investment strategies. Within this asset management ecosystem, another key player is index providers, such as MSCI, which, among other responsibilities, determine the composition of ESG funds and define which assets are considered green (Fichtner et al., 2023). Finally, another key player in the mobilization and expansion of green finance is private banks. They play a crucial mediating role within the global green finance ecosystem: in their daily operations, they make decisions regarding the financing of sustainable economic practices and energy projects, as well as the potential non-financing of fossil fuel-based energy sources (Babic, 2024). Unlike other private actors, such as large asset managers, which were discussed previously, banks typically do not actively inject large sums into the green financial system. Instead, they offer a range of green financial products or underwrite green bonds, serving as intermediaries between investors and target projects (Akomea-Frimpong et al., 2022). Private actors are key components in the green financial system because they have the majority of funds at their disposal.

Taking everything into consideration, the actors in green finance can be broadly divided into two categories: public and private. Public actors primarily consist of government institutions, such as finance ministries and Public Development Banks, while private actors include institutional investors and private banks. Positioned between the public and private sectors, central banks play a crucial role by shaping existing policies, creating new ones, promoting green financial instruments, and purchasing them. It is evident that achieving meaningful results requires collaboration among all these actors.

1.5. Bibliometric Analysis of Sustainable Development

After adoption of The 2030 Agenda for Sustainable Development in 2015, the sustainable development topic has emerged. According to Hickel (2020), sustainable development is a multifaceted measure of a country's overall progress, encompassing factors such as average life expectancy, carbon emissions, education levels, material footprint, and income.

There are 17 sustainable development goals (United Nations, 2015):

1. End poverty in all its forms everywhere;

2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture;
3. Ensure healthy lives and promote well-being for all at all ages;
4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all;
5. Achieve gender equality and empower all women and girls;
6. Ensure availability and sustainable management of water and sanitation for all;
7. Ensure access to affordable, reliable, sustainable and modern energy for all;
8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all;
9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation;
10. Reduce inequality within and among countries;
11. Make cities and human settlements inclusive, safe, resilient and sustainable;
12. Ensure sustainable consumption and production patterns;
13. Take urgent action to combat climate change and its impacts;
14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development;
15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss;
16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels;
17. Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development.

The report of Progress towards the Sustainable Development Goals (2024) shows that only 17% of sustainable development goals are on course to be met, while nearly half are making minimal or moderate progress, and progress on more than a third has either stalled or regressed. The 7th and 12th goals have 40% fulfillment which is the highest rate between goals. However, the report highlights that in 2022 global access to electricity declined for the first time in ten years because of COVID-19, despite advancements in energy efficiency and the growth of renewable energy. According to the United Nations, to achieve the 7th goal, electrification efforts must be accelerated, investments in renewable energy must be increased, supportive policies and regulatory frameworks

should be implemented. Regarding the 12th goal, it is worth mentioning that public funding for the production and consumption of fossil fuels has more than tripled since 2015, hindering progress toward a net-zero emissions transition which has the biggest impact on 40% of fulfillment. On the other hand, every day, one billion meals' worth of edible food is wasted in households across the globe and only 9 out of 193 countries have included food waste in their national agendas. The biggest regression is visible in the 2nd goal, it is mainly related to the fact that almost 60% of countries globally experienced significant rises in food prices due to conflicts and disrupted supply chains. Achieving zero hunger requires intensified efforts to transform food systems towards sustainability, resilience, and equity, while also accelerating improvements in diets, nutrition, health, and hygiene to meet the Sustainable Development Goals target of halving childhood chronic undernutrition. The remaining goals are mostly at moderate progress, which means governments must stay united behind the 2030 Agenda and take the essential steps required to achieve transformative progress by 2030, at a significantly faster pace and larger scale.

After 2015, the literature on sustainable development has also increased, therefore, it is important to have a scientific overview of sustainable development. The literature analysis of sustainable development has been performed using VOSviewer system and is presented in the Figure 1.

The frequency distribution of keywords offers a clear and efficient way to outline the research domains and key themes within a specific discipline (Zheng, 2024). In this case, a co-occurrence analysis of sustainable development has been conducted on 10,000 articles from the Web of Science, covering the period from 2022 to 2025, and seven clusters which are presented in different colors have been created.

The first cluster, which is in red, is the biggest one and represents 227 items. Main words are sustainable development, sustainable development goals, framework. It is visible that sustainable development is related to all clusters, however, it is worth mentioning that sustainable development goals also reach all 7 clusters, on the other hand, framework is only related to purple, blue, green and brown clusters. When analyzing the Sustainable Development Goals, this cluster could be assigned to the 2nd, 6th, 11th, 13th, 14th, 15th and 17th goals. The 2nd goal addresses hunger, nutrition, and sustainable agriculture – topics that are important in the red cluster. Of these three words, agriculture is the most significant. It is related to the green cluster because of sustainability and to the purple cluster because of innovation. The 6th goal deals with water management, which is covered in the red cluster by terms like water management and groundwater. The 11th goal focuses on cities and their sustainability. While city is covered in the red cluster, it is also related to the green cluster when discussing sustainability, to the brown cluster in terms of challenges, and to the blue cluster when

referring to cities in China. Another key aspect is that inclusion, safety, and resilience are addressed in the red cluster. Therefore, it can be concluded that the 11th goal is represented in scientific analysis. The 13th goal, which addresses climate change, is one of the most crucial topics in the red cluster, as reflected in its size. Climate change is also related to other clusters – for example, to the green cluster because of sustainable development goals, to the purple cluster because of management, and to the blue cluster due to renewable energy and its impact. Another important topic is marine life, covered in the 14th goal. This is part of the red cluster, which includes terms like sea and blue economy. However, given the significance of this issue in the Sustainable Development Goals, there may be more relevant information in the selected 10,000 articles. The red cluster also addresses the 15th goal, which focuses on forests and biodiversity. The main word is biodiversity, which is also related to the purple cluster in terms of management. Ecosystems and forests are briefly mentioned in the red cluster, but more analysis is expected, as these are crucial topics in the context of climate change and reducing CO₂ emissions. Finally, this cluster covers the 17th goal, by including the words partnerships and sustainable development which is the most covered topic here.

In the second cluster, which is presented in green and consists of 203 items, the most common words are sustainability, education, education of sustainable development. Looking at this cluster, it can be concluded that it is related to education – not only in a broader sense, such as university, higher education, teacher education, and students, but also to education for sustainable development, sustainable tourism, and even ecotourism. The sustainability topic is linked to the red, purple, blue, brown, and cyan clusters, which means that it is not related only to the orange cluster. When considering the Sustainable Development Goals, it can be concluded that this cluster is related to the 3rd, 4th, 5th, and 12th goals. The 3rd goal promotes healthy life and well-being which is covered in this cluster by topics such as health and healthcare. The 4th goal focuses on education and lifelong learning, and as already mentioned, the most important topic in this cluster is education in a broader sense. The 5th goal is related to gender equality and women's rights. The green cluster covers gender equality and gender separately, as well as women, so it can be concluded that this goal is covered in the scientific literature. The 12th goal is partially covered in this cluster because it addresses sustainable consumption, but consumption is a more prominent topic in the blue cluster.

also related to the red, green, and brown clusters. The 8th goal emphasizes the importance of economic growth, which is one of the central topics in this cluster. It connects to the red cluster in terms of governance and urbanization, the brown cluster in terms of energy, and the purple cluster in terms of innovation. The 10th goal is also part of this cluster, as it addresses income inequality and broader inequality, which are related to poverty and sustainable development, according to the literature review. As analyzed in the second cluster, this blue cluster covers the 12th goal as well, since consumption is linked to the red (sustainable development and sustainable development goals), green (sustainability), brown (energy and model), and purple (management and quality) clusters. The 16th goal, which focuses on societies and institutions, is also represented in this cluster, as terms like institutional quality and social justice are included. This suggests that authors analyze these aspects in their research on sustainable development.

The fourth cluster is presented in brown and contains 166 items. The most quoted frequently quoted words in this cluster are model, challenges, systems. Model and challengers are connected to the green, red, purple, blue and cyan clusters, meaning that only the orange cluster is not linked to them, while systems are linked to the green, red, purple, and blue clusters. This cluster addresses one of the most critical issues in the Sustainable Development Goals and is related to the 12th goal – waste management. Additionally, sustainable agriculture and sustainable materials could also be associated with this goal. Moreover, the 7th goal, which addresses energy issues, is a relevant topic in this cluster. It is connected to the red cluster through sustainable development goals, environment, and progress; to the green cluster through sustainability; to the purple cluster through management and performance; to the cyan cluster through technology; and to the blue cluster through 9 topics, with the most important being renewable energy, impact, and growth. Therefore, it can be concluded that this cluster analyzes the 7th goal in depth.

The fifth cluster represents 165 items and is purple. The key words are performance, management, and innovation. Management relates to all seven clusters, including the main topic – sustainable development – as well as sustainability, which is the main topic in the green cluster, and renewable energy, which is the main topic in the blue cluster. This leads to the conclusion that management is a crucial topic when discussing sustainable development. Performance is no exception; it is related to all the main topics in the red, green, and blue clusters. Nevertheless, it is important to note that performance is also linked to strength and durability in the brown cluster, technology in the cyan cluster, and industry in the orange cluster. In analyzing innovation, it is connected to key elements in the red, green, brown, and blue clusters. However, it is worth noting that in the cyan cluster, it is linked to technology and the future, which form the background of innovation. Another important aspect is that in the red cluster, innovation is related to agriculture, a

vital topic in the Sustainable Development Goals, particularly Goal 2. However, innovation is also mentioned in the 9th goal, therefore, this cluster also covers this goal.

The sixth cluster is cyan and consists of 41 items. The main words are technology, future, covid-19. Technology is an important topic in the red cluster when discussing sustainable development and the sustainable development goals. In the green cluster, it is crucial to address sustainability; in the brown cluster, it is related to energy and models, while in the blue cluster, it is solely connected to impact. The word future is connected to sustainability and sustainable development in the green and red clusters, respectively, while the importance of the purple cluster has already been discussed. Even though COVID-19 has been a major setback in achieving the Sustainable Development Goals, bibliographic analysis has shown that it is related only to sustainable development (red cluster), management (purple cluster), and education (green cluster). Talking about specific goals, this cluster can be related to the 8th goal by employment. Even though, based on the size of the bubble, it is not the most vital, the employment topic has been covered in the articles.

Finally, the smallest cluster is the orange one, which contains 28 items. The most prominent items are industry and environmental. Industry has the highest visibility in this cluster and is connected to the red cluster regarding sustainable development, to the blue cluster regarding China and impact, and to management and performance in the purple cluster. It is worth mentioning that industry is related to the 9th goal by industrialization. The word environmental is linked to the main topic – sustainable development. Therefore, while this cluster is small, it plays an important role in analyzing industry and other niche topics, such as key performance indicators and risk management.

Taking everything into consideration, bibliography analysis by using VOSviewer is a powerful tool to analyze a broad topic. Currently, sustainable development is a huge topic in the science field and is related to many different fields, starting from agriculture, education, tourism, urbanization and moving to innovation, renewable energy, technology or industry. The seven clusters have shown the most vital topics in the sustainable development field which are related to sustainable development goals, which gives a conclusion that sustainable development is integral part of sustainable development goals.

1.6. Overview of Green Finance and Sustainable Development in Baltic Sea Region Countries

Currently, green finance and sustainable development have been analyzed from theoretical point of view, now it is important to analyze how these topics are addressed in relation to the countries of the Baltic Sea Region. Baltic Sea Region countries are Denmark, Germany, Poland, Finland, Sweden, Latvia, Lithuania, and Estonia.

Gharleghi et al. (2024) conducted research on the role of green bonds and their impact on sustainability in Germany and European Union countries. The authors (2024) report that the largest volume of green bond issuance occurred in 2022 (90 billion euros), which decreased to almost 30 billion euros in 2023. In the European Union (excluding Germany), the volume of green bonds issued in 2022 was 250 billion euros, dropping to below 150 billion euros in 2023. Using a panel fixed-effect regression model, the authors concluded that initiatives such as the value of green bonds issued, general expenditure on environmental protection, environmental tax revenue, and fossil fuel subsidies in Germany have a stronger impact on reducing greenhouse gas emissions compared to European Union countries, indicating that the impact on sustainability is higher in Germany.

Another important topic is whether green policy reduces greenhouse gas emissions. Primic et al. (2024) concluded that Finland which has similar green recovery budget to Sweden, increased greenhouse gas emissions by 12%, while Sweden reduced it during the period from the second quarter of 2019 until second quarter of 2022. The Finland's example illustrates that green recovery measures by themselves do not automatically result in reduced GHG emissions. This highlights the need for a holistic approach when assessing the impact of green policies on emissions, considering various factors such as industry types, policy effectiveness, energy costs, adoption of eco-friendly technologies, weather patterns, and natural disasters (Primic et al., 2024). Talking about greenhouse gas emissions, interesting example is Lithuania and Latvia, despite having comparatively big green recovery budgets, these countries faced adverse impact on greenhouse gas emissions during the COVID-19. Primic et al. (2024) explains it by significant reliance on specific industries, ineffective implementation of environmental regulations, lengthy policy implementation processes, limitations in infrastructure development, and the interaction of socioeconomic factors. Moreover, Latvia sought to rejuvenate degraded areas and attract investments to support business development in line with its economic specialization. The objective was to stimulate job creation in the private sector and promote non-financial investments from private companies, thereby tackling the urgent need for economic growth, which led to a negative impact on green gas house emissions (Primic et al., 2024). All in all, green financial policies are generally seen as beneficial for reducing greenhouse gas emissions. However, countries like Latvia and Lithuania, which joined the European Union more recently, have demonstrated that the growing demand for energy services has outweighed the positive effects of green investments.

Green finance is a crucial aspect to achieve sustainability goals and one of the main instruments of green finance are grants and loans. Primic et al. (2024) observes that Estonia, Sweden, Germany, and Denmark all reduced greenhouse gas emissions during the pandemic, with all countries – except Estonia – employing a variety of policy measures while relying on a relatively small

proportion of grants and loans. For example, Germany introduced several green financing mechanisms, including R&D subsidies for cleaner shipping, increased support for electric vehicle purchases, and grants for developing clean hydrogen capacity. Meanwhile, Sweden implemented a range of green financing initiatives, such as a skills development program, tax reductions for green technologies, R&D subsidies for biogas production, and compensation for forest owners (Primic et al., 2024). On the other hand, Latvia, Lithuania, Finland and Poland relied primarily on grants and loans and encountered challenges reducing their greenhouse gas emissions. To sum up, Primic et al. (2024) found a positive correlation between the proportion of grants and loans in green recovery measures and the greenhouse gas emissions index, which tracks changes in emissions from the beginning to the end of the pandemic.

To conclude, green finance and sustainable development are mainly analyzed at the European Union level, and it helps to find information about Baltic Sea Region countries in this context. The best examples in achieving sustainability goals by using green finance are old European Union countries such as Germany, Sweden and Denmark, while Lithuania, Latvia, Estonia, Poland and Finland are facing difficulties to reduce for example greenhouse gas emissions even though their budgets have increased.

2. RESEARCH METHODOLOGY FOR ASSESSING THE IMPACT OF GREEN FINANCE ON SUSTAINABLE DEVELOPMENT IN BALTIC SEA REGION COUNTRIES

The main aim of this thesis is to develop a comprehensive methodology to examine the impact of green finance on sustainable development outcomes in the Baltic Sea Region countries. As the review of scientific literature revealed, research on this topic remains limited, which underscores the importance of further exploration in the context of the 2030 Agenda and the European Green Deal. The methodological framework builds upon the approach proposed by Sun et al. (2025), who analyzed the nexus between green finance and sustainable development across 46 countries. In this study, eight Baltic Sea Region countries – Lithuania, Latvia, Estonia, Finland, Sweden, Denmark, Germany, and Poland – are examined. To assess the effects of green finance on various sustainability dimensions, several econometric techniques are employed, including pooled Ordinary Least Squares (OLS), Fixed Effects, and Random Effects panel regression models, complemented by diagnostic tests such as the Variance Inflation Factor (VIF), Breusch–Pagan Lagrange Multiplier, and Hausman tests. The analysis incorporates indicators such as the Sustainable Development Index, the share of renewable energy in total energy consumption, the Institutional Quality Index, and the Human Development Index, alongside economic and financial variables including green and sustainability-linked bond issuance, GDP per capita, foreign direct investment, and population.

2.1. Structure of the Research Process

In order to evaluate the impact of green finance on sustainable development outcomes in Baltic Sea region countries, a main hypothesis should be established.

1st hypothesis. Green finance positively influences sustainable development indicators.

The literature review has shown that countries that have issued more green bonds tend to have a stronger impact on reducing greenhouse gas emissions (Gharleghi et al., 2024). Since green finance is closely related to environmental objectives, it is not surprising that it has a positive impact on environmental outcomes. However, green finance can also positively influence governance aspects due to its high reporting and transparency standards (ICMA, 2021).

2nd hypothesis. Green bond issuance positively correlates with the share of renewable energy in total energy consumption. Renewable energy has been gaining a growing share of the market over the years, and it is expected to continue increasing. In European Union countries, solar PV accounts for the largest share by far – nearly 70% of the region’s capacity growth between 2024 and 2030. Furthermore, renewable energy is forecasted to grow at a compound annual growth rate (CAGR) of 8.5% from 2024 to 2033 (International Energy Agency, 2024). Therefore, it is important

to analyze whether green bond issuance is positively correlated with renewable energy development, considering its projected growth rate.

3rd hypothesis. Green finance positively impacts the Human Development Index (HDI) in Baltic Sea region countries. HDI is crucial when assessing the social sustainability aspect, as it measures life expectancy, knowledge (expected years of schooling), and a decent standard of living through GNI per capita. While green finance is not necessarily directly linked to HDI, it can be positively correlated. For example, green finance supports investments in clean energy, which reduces air pollution and improves public health – factors that positively influence life expectancy. Moreover, investments in clean transportation can increase access to education in rural areas, and green investments can create well-paid jobs and improve income levels. Therefore, it is important to go beyond straightforward hypotheses and estimate whether green finance has a positive impact on sustainable development in a broader context.

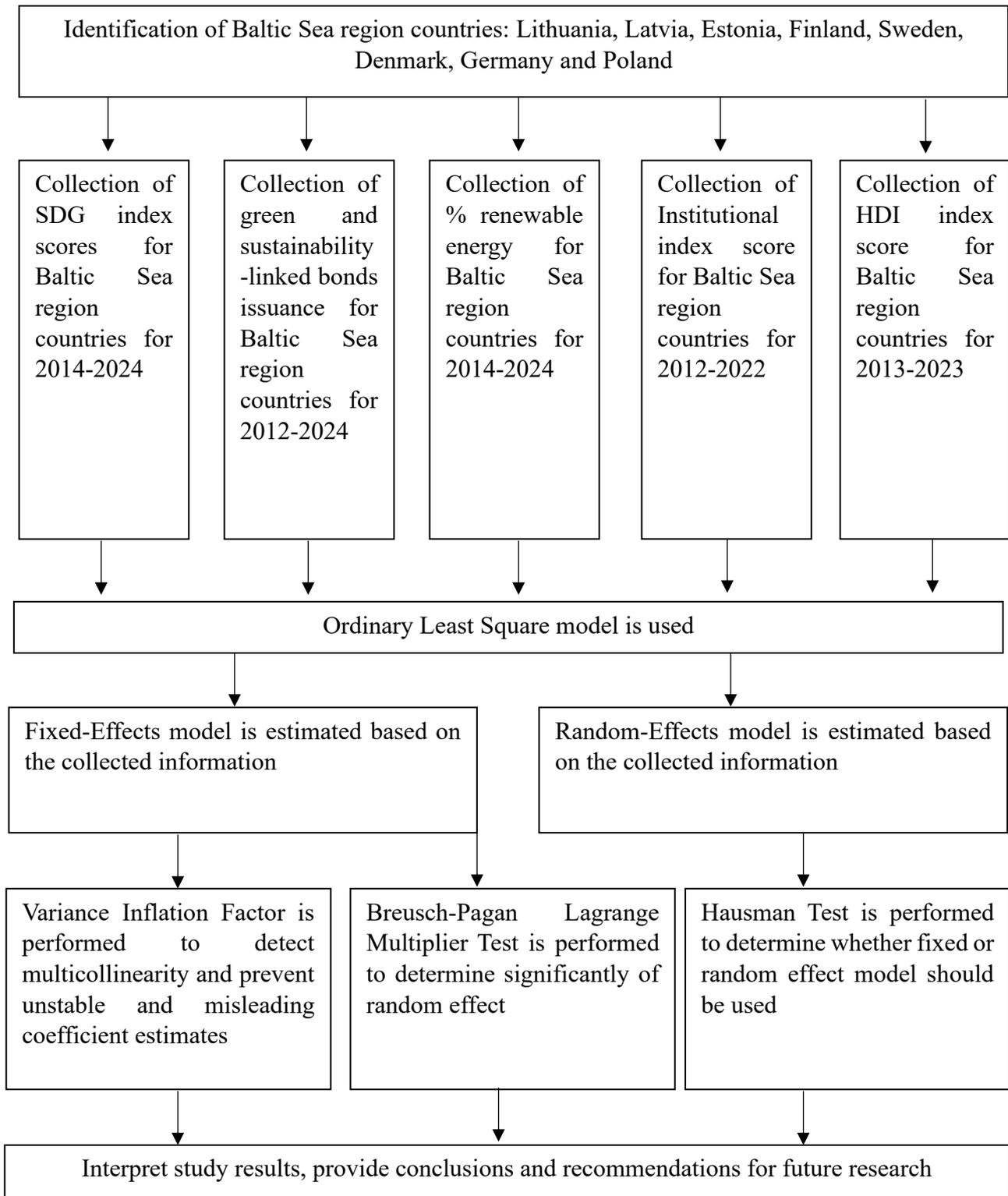
4th hypothesis. Higher levels of green finance are associated with improved institutional quality in Baltic Sea region countries. From a governance perspective, institutional quality is crucial for green finance investments, as it promotes foreign direct investment (Liu et al., 2024). However, it is also relevant in the context of greenwashing, particularly from the perspectives of corruption control and regulatory quality. Institutional quality is typically measured by indicators such as regulatory quality, control of corruption, rule of law, government effectiveness, and voice and accountability. These dimensions are all components of governance, and they can be used to assess whether green finance has an impact on governance-related outcomes.

The research scheme is presented in Figure 2. In the first step, Baltic Sea region countries are identified. In the second step, relevant data for the regression analysis is collected. The values of the dependent variables – including the SDG Index, the share of renewable energy in total energy consumption, the Institutional Quality Index, and the HDI score – for the period 2012–2024 are organized. The independent variable, green and sustainability-linked bond issuance, is also collected, along with control variables such as GDP per capita, foreign direct investment, and population. Once all relevant statistical data for the Baltic Sea Region countries for the 2012–2024 period are collected, panel data regression techniques are employed to analyze the relationships between green finance and various dimensions of sustainable development. Both Fixed Effects and Random Effects models are estimated to account for potential unobserved heterogeneity across countries and over time. The Hausman test is then applied to determine the most appropriate model specification, based on whether the unobserved individual effects are correlated with the explanatory variables. If the null hypothesis of no correlation is rejected ($p < 0.05$), the Fixed Effects model is preferred, otherwise, the Random Effects model is deemed more suitable. To ensure the robustness and validity of the regression results,

additional diagnostic tests are performed, including the Variance Inflation Factor to assess multicollinearity, the Breusch–Pagan Lagrange Multiplier test to detect the presence of significant individual effects, and robust standard error adjustments to control for potential heteroskedasticity.

Figure 2

Research Framework



Source: figure constructed by the author.

A ten-year period has been chosen because, based on previous research in this field (Sun et al. (2025), Gharleghi et al. (2024)), a ten-year timeframe is sufficient for such an analysis. Due to the lack of information, not all variables can be analyzed over the same period of time, however, all variables within each hypothesis share an identical ten-year time frame. Furthermore, as highlighted in the literature review, the ESG topic is still relatively new and rapidly evolving, therefore, focusing on the most recent period provides the most relevant and up-to-date information.

2.2. Data Sources

The empirical analysis in this thesis is based on a panel dataset covering eight Baltic Sea Region countries: Lithuania, Latvia, Estonia, Poland, Finland, Sweden, Denmark, and Germany. The variables and data sources used in the research are presented in Table 4. To ensure cross-country comparability, all data for the Baltic Sea Region countries were obtained from the same international databases.

For all four hypotheses, the total amount of green bonds and sustainability-linked bonds (in USD billions) was taken from the International Monetary Fund database. To evaluate overall progress toward the Sustainable Development Goals, the Sustainable Development Goals Index and the share of renewable energy in total energy consumption (in percent) were used. Additionally, the Human Development Index, the Institutional Quality Index, and the Democracy Index were included to capture broader dimensions of sustainable development. These indicators allow for an assessment of social and governance-related progress: the HDI reflects life expectancy, education, and income levels, while the Institutional Quality Index measures governance performance, regulatory effectiveness, and the rule of law.

Table 4

Measurements of Variables

Variable	Abbr.	Measures	Source(s)
Sustainable Development Goals Index	SDI	The index score indicates the country's position on a scale from 0 (worst) to 100 (optimum performance)	Sustainable Development Solutions Network
Green Bonds and Sustainability-linked Bonds issuance	GF	Green and sustainability-linked bonds are fixed-income securities created to support climate and environmental projects	IMF calculations

Continuation of Table 4

Gross Domestic Product	GDP	GDP per capita in US \$ for a specific year	World Development Indicators
Foreign Direct Investment	FDI	FDI, net inflows in US \$ for a specific year	World Bank
Population	Population	People living in a country in a specific year	World Bank
Renewable Energy	RE	% of a renewable energy to total energy	BP Statistical Review
Energy Price	EP	Energy prices in euros for a specific year	International Energy Agency
Human Development Index	HDI	HDI report containing health of life and GINI index	United Nations
Educational Expenditures	EdEx	Educational expenditures as a % of GDP	World Bank
Healthcare expenditures	HEX	Healthcare expenditures per capita	World Bank
Institutional Quality Index	IQI	Worldwide Governance Indicators	World Bank
Democracy Index	DI	The score of the democracy index	Economist Intelligence Unit

Source: table constructed by the author based on the provided sources.

The remaining variables describe the socio-economic context that is essential for this research. GDP per capita (in USD) represents economic development, foreign direct investment (in USD) captures investment activity, population accounts for country size differences, and education and healthcare expenditures (as a percentage of GDP) indicate government commitment to social infrastructure which is an important factor when analyzing sustainable development outcomes.

Finally, the study's results will be analyzed and interpreted, and conclusions along with recommendations for future research will be presented.

2.3. Methodological Framework of Research

It is crucial to choose the correct method of research in order to correctly analyze the hypothesis. In this research, the panel regression model is suitable because the panel data regression model is constructed using panel data, which comprises observations on the same cross-sectional units – such as countries or individuals – across multiple time periods (Aristodemou, 2021). Panel data will be collected of Lithuania, Latvia, Estonia, Finland, Sweden, Denmark, Germany and Poland during 2012-2024 period.

Furthermore, Fixed Effect Model will be used. According to Gujarati & Porter (2009), this model is a panel data estimation technique used to account for unobserved heterogeneity across individuals by allowing for individual-specific intercepts. This approach adjusts for differences between cross-sectional units through variations in the intercept term, while assuming constant slopes across individuals. The model can be estimated using a dummy variable approach, where each individual and time period is represented by a dummy variable. One common type of Fixed Effect Model assumes that while the slope coefficients remain constant across all units, the intercepts vary for each individual. This specification captures cross-sectional differences while ignoring potential time effects. On the other hand, Random Effect Model treats individual effects as part of the error term and does not account for sudden changes (Ullah, A. et al 2021). In order to perform Fixed Effect Model and Random Effect Model analysis, Ordinary Least Squares model needs to be created, and it is shown in the 1st formula for the 1st hypothesis.

$$SDI_{i,t} = \beta_0 + \beta_1 GF_{i,t} + \beta_2 GDP_{i,t} + \beta_3 FDI_{i,t} + \beta_4 Population_{i,t} + \epsilon_{i,t} \quad (1)$$

where, i – country, t – time, SDI – sustainable development index, GF – green bonds and sustainability-linked bonds issuance, GDP – gross domestic product per capita, FDI – foreign direct investment, ϵ - error.

Regarding Fixed Effect Model, it includes a dummy variable or country specific intercept, and it is shown in the 2nd formula:

$$SDI_{i,t} = \beta_0 + \alpha_i + \beta_1 GF_{i,t} + \beta_2 GDP_{i,t} + \beta_3 FDI_{i,t} + \beta_4 Population_{i,t} + \epsilon_{i,t} \quad (2)$$

where α_i – fixed effect for each country.

Finally, Random Effect Model includes random effects which capture unobserved, time-invariant characteristics specific to each country which uncorrelated with explanatory variables, it is shown in the 3rd formula:

$$SDI_{i,t} = \beta_0 + \beta_1 GF_{i,t} + \beta_2 GDP_{i,t} + \beta_3 FDI_{i,t} + \beta_4 Population_{i,t} + \epsilon_{i,t} + u_i \quad (3)$$

where, u_i is random effect.

In analyzing the second hypothesis, the Sustainable Development Index will be replaced by the share of renewable energy in total energy production for each of the analyzed countries. Additionally, the annual energy price in each country will be included as an independent variable. The Ordinary Least Squares regression formula is as follows:

$$RE_{i,t} = \beta_0 + \beta_1 GF_{i,t} + \beta_2 GDP_{i,t} + \beta_3 EP_{i,t} + \beta_4 Population_{i,t} + \epsilon_{i,t} \quad (4)$$

where, RE – % of a renewable energy to total energy, EP – energy price for unit.

Fixed Effect Model will use the following formula for the second hypothesis:

$$RE_{i,t} = \beta_0 + \alpha_i + \beta_1 GF_{i,t} + \beta_2 GDP_{i,t} + \beta_3 EP_{i,t} + \beta_4 Population_{i,t} + \epsilon_{i,t} \quad (5)$$

Random Effect Model formula for the second hypothesis:

$$RE_{i,t} = \beta_0 + \beta_1 GF_{i,t} + \beta_2 GDP_{i,t} + \beta_3 EP_{i,t} + \beta_4 Population_{i,t} + \epsilon_{i,t} + u_i \quad (6)$$

For the second hypothesis, it is crucial to analyze renewable energy consumption as a percentage of total energy consumed during the given period. Energy prices represent a relevant independent variable and will be examined for each country over the 2014–2024 period. Since fluctuations in energy prices can influence renewable energy consumption – for example, higher fossil fuel prices may lead to increased renewable energy use – this independent variable enhances the credibility of the model.

The third hypothesis examines the Human Development Index (HDI) in Baltic Sea Region countries. Therefore, the dependent variable will be the HDI, while the independent variables will include education expenditure as a percentage of GDP and healthcare expenditure per capita, to enable a more comprehensive analysis. The Ordinary Least Squares regression formula is as follows:

$$HDI_{i,t} = \beta_0 + \beta_1 GF_{i,t} + \beta_2 GDP_{i,t} + \beta_3 EdEx_{i,t} + \beta_4 HEx_{i,t} + \epsilon_{i,t} \quad (7)$$

where, HDI – human development index, EdEx – educational expenditures as a % of GDP, HEx – healthcare expenditures per capita.

Fixed Effect Model formula for the third hypothesis:

$$HDI_{i,t} = \beta_0 + \alpha_i + \beta_1 GF_{i,t} + \beta_2 GDP_{i,t} + \beta_3 EdEx_{i,t} + \beta_4 HEx_{i,t} + \epsilon_{i,t} \quad (8)$$

Random Effect Model formula for the third hypothesis:

$$HDI_{i,t} = \beta_0 + \beta_1 GF_{i,t} + \beta_2 GDP_{i,t} + \beta_3 EdEx_{i,t} + \beta_4 HEx_{i,t} + \epsilon_{i,t} + u_i \quad (9)$$

Including these independent variables will improve the accuracy of the results, as the HDI comprises three dimensions: health, education, and standard of living. Therefore, incorporating education and healthcare expenditure helps better capture the factors influencing the HDI.

The final hypothesis examines whether green finance has an impact on institutional quality, taking into account the regulatory and transparency requirements that issuers must meet when issuing green financial instruments, particularly green bonds. The Ordinary Least Squares regression formula for this hypothesis is as follows:

$$IQI_{i,t} = \beta_0 + \beta_1 GF_{i,t} + \beta_2 GDP_{i,t} + \beta_3 FDI_{i,t} + \beta_4 DI_{i,t} + \epsilon_{i,t} \quad (10)$$

where, IQI – Institutional Quality Index, DI – Democracy Index.

Fixed Effect formula for the fourth hypothesis:

$$IQI_{i,t} = \beta_0 + \alpha_i + \beta_1 GF_{i,t} + \beta_2 GDP_{i,t} + \beta_3 FDI_{i,t} + \beta_4 DI_{i,t} + \epsilon_{i,t} \quad (11)$$

Random Effect formula:

$$IQI_{i,t} = \beta_0 + \beta_1 GF_{i,t} + \beta_2 GDP_{i,t} + \beta_3 FDI_{i,t} + \beta_4 DI_{i,t} + \epsilon_{i,t} + u_i \quad (12)$$

Institutional quality, measured using the Worldwide Governance Indicators, will help assess whether green finance contributes to improved governance. A new independent variable – the Democracy Index – is strongly associated with institutional quality. In addition, economic variables such as GDP per capita FDI may positively influence institutional quality, as economic growth and external investment can drive institutional improvements through increased pressure for transparency, accountability, and reform.

After the Ordinary Least Square, Fixed Effect and Random Effect methods are performed, it is needed to test whether there is a multicollinearity. Multicollinearity is an absence of correlation between two or more independent variables (Saunders et al., 2019). Variance Inflation Factor is calculated between independent variables and if the multicollinearity was determined, then variables will be eliminated to minimize the collinearity between the independent variables. It represents the ratio between the variance of a regression coefficient in the presence of multicollinearity and the variance of that coefficient if no multicollinearity were present among the explanatory variables (Cheng et al., 2022). The formula is as follows (Vu et al., 2015):

$$VIF_i = \frac{1}{1 - R_i^2} \quad (13)$$

where, R_i^2 – coefficient of degree of determination between the i^{th} variable x_i in the matrix of independent variables and all other explanatory variables. This is obtained by performing an Ordinary Least Squares regression with x_i as the dependent variable and the remaining variables as independent variables, thereby capturing the extent of correlation between x_i and the rest of the predictors.

According to Gomez et al. (2020), in the absence of collinearity between the variable x_i and the other explanatory variables, the coefficient of determination R_i^2 would equal zero, resulting in a VIF_i of 1. However, this represents an ideal scenario. In practice, some degree of collinearity among independent variables is typically present. As the linear association between x_i and the other variables increases, the value of R_i^2 rises, leading to a corresponding increase in VIF_i . Thus, a higher VIF indicates more severe multicollinearity. Empirical research commonly considers a VIF value exceeding 10 as evidence of problematic multicollinearity. Therefore, if VIF will be more than 10, then independent variables will be removed.

Furthermore, the Breusch–Pagan Lagrange Multiplier test will be used to determine whether random effects are present in the panel data. The test involves two hypotheses: the null hypothesis (H_0) assumes that there are no random effects, indicating that the Ordinary Least Squares method is appropriate; the alternative hypothesis (H_1) assumes that random effects are present, suggesting that a random effects model is more suitable. The formula is as follows (Breusch & Pagan, 1980):

$$LM = \frac{N \cdot T}{2(T-1)} \left(\frac{e_i^2}{\delta^2} - 1 \right)^2 \quad (14)$$

where, N – number of cross-sectional units, T – number of time periods, e_i^2 average of residuals for each individual i from OLS, δ^2 – overall error variance from OLS.

Finally, the Hausman test will be conducted to determine whether the fixed effects model or the random effects model is more appropriate, as this test assesses whether the unique errors are correlated with the regressors. The test involves two hypotheses. The null hypothesis (H_0) states that there is no correlation between the individual effects and the regressors, indicating that the random effects model is suitable. The alternative hypothesis (H_1) asserts that there is a correlation between the individual effects and the regressors, in which case the fixed effects model is more appropriate. The formula is as follows (Hausman, 1978):

$$H = (\beta_{RE} - \beta_{FE})' [Var(\beta_{RE}) - Var(\beta_{FE})]^{-1} (\beta_{RE} - \beta_{FE}) \quad (15)$$

where, β_{RE} – coefficient estimates from the random effects model, β_{FE} - coefficient estimates from the fixed effects model.

The presented research scheme includes panel regression, as well as Fixed-Effects and Random-Effects regression models. After the regressions are performed, the Variance Inflation Factor, Breusch-Pagan Lagrange Multiplier test, and Hausman test will be conducted to analyze the results.

3. RESEARCH OF GREEN FINANCE AND SUSTAINABLE DEVELOPMENT IN BALTIC SEA REGION COUNTRIES

According to European Commission, over the coming decade, the Commission aims to mobilize no less than €1 trillion for sustainable investments, and European Union countries must allocate at least 37% of the financing under the Recovery and Resilience Facility to investments and reforms that do not significant harm to the European Union’s environmental objectives (European Commission, 2020). Since all Baltic Sea Region countries are part of the European Union, it is crucial to analyze the current development of green finance and sustainability in these countries that the impact of the Green Deal and NextGenerationEU financing can be explored in the future.

The research will test four hypotheses described in the methodology section of this thesis. The first hypothesis examines whether green and sustainability-linked bonds have an effect on sustainable development goals. The data used to test this hypothesis are presented in Annex 1 and consist of the Sustainable Development Index, the amount of green and sustainability-linked bonds issued (in billions of U.S. dollars), GDP per capita (in U.S. dollars), net foreign direct investment (in U.S. dollars), and population. All these metrics are analyzed over the 2014–2024 period and will be tested using R package software.

Table 5

OLS results for 1st hypothesis

	Estimate	Standard Error	t-value	p-value
GF_log	-0.056258	0.344084	-0.1635	0.871152
GDP_log	5.234162	1.889837	2.7696	0.009262**
FDI_log	0.988424	0.333143	2.9670	0.005651**
Population_log	-1.529293	0.438291	-3.4892	0.001434**
R²	0.63761			
F-statistic	14.0758			9.9095 ^{e-07}

Source: table constructed by the author, based on empirical study.

First of all, ordinary least square method is performed and results are presented in the Table 5. To improve the statistical validity of the models, the independent variables were transformed using natural logarithms. It was applied because economic indicators are often highly skewed, with a few extreme values disproportionately influencing the estimation results and also, to accommodate the presence of zero values in some variables (e.g., green bonds issuance during a year), the transformation was applied using the $\log(1 + x)$ specification, which ensures that all values remain defined.

The regression results provide important insights into the factors influencing sustainable development. Contrary to the initial hypothesis, green finance does not appear to have a statistically significant effect on the SDI. The coefficient for green finance is negative but not significant, suggesting that, within the observed period, the issuance of green and sustainability-linked bonds has not yet translated into measurable progress in sustainable development outcomes. In contrast, GDP per capita and foreign direct investment both display positive and statistically significant effects on SDI, highlighting the role of economic growth and international investment as key drivers of sustainable development. Additionally, population size exerts a significant negative effect on SDI, indicating that demographic pressures may hinder progress toward sustainability. The overall model demonstrates a good fit, explaining approximately 64% of the variation in SDI, and is statistically significant at the 1% level. The pooled OLS model is statistically significant ($F = 14.0758$, $p = 9.91 \times 10^{-07}$), indicating that green finance, GDP, FDI, and population jointly explain a meaningful share of variation in the Sustainable Development Index across countries and years. These findings suggest that while green finance initiatives may hold potential in theory, their practical impact on sustainable development remains limited compared to broader economic and demographic factors. Furthermore, it should be noted that in Lithuania, Latvia, and Estonia, there are more years in which green and sustainability-linked bonds were not issued than years in which they were issued.

While the OLS model provides an initial overview of the relationship between green finance, economic variables, and sustainable development, it does not account for unobserved heterogeneity across countries. Since the dataset spans multiple countries with distinct structural characteristics, relying solely on pooled results may lead to biased estimates. To address this limitation, a Fixed Effects model was employed, allowing for the control of time-invariant country-specific factors and focusing instead on within-country variation over time.

Table 6

Fixed Effect results for 1st hypothesis

	Estimate	Standard Error	t-value	p-value
GF_log	0.154133	0.092266	1.6705	0.106371
GDP_log	2.262107	0.795159	2.8448	0.008375**
FDI_log	-0.039798	0.084073	-0.4734	0.639757
Population_log	-9.046758	4.959627	-1.8241	0.079277*
R²	0.706			
F-statistic	16.209			7.0016×10^{-07}

Source: table constructed by the author, based on empirical study.

To account for the panel structure of the dataset, a Fixed Effects (FE) regression model was estimated. Unlike the pooled OLS approach, which assumes homogeneity across countries, the FE model controls for unobserved, time-invariant characteristics specific to each country, such as institutional frameworks, governance traditions, or geographical factors. This allows the model to capture within-country variations over time, thereby providing more accurate estimates of the relationship between explanatory variables and the SDI. The results of the FE model demonstrate that GDP per capita is a strong and statistically significant predictor of SDI, with a positive coefficient, indicating that economic growth contributes positively to sustainable development within countries over the period analyzed. Population size exhibits a negative effect on SDI, which is marginally significant, suggesting that higher population levels may place additional strain on sustainability outcomes. In contrast, the coefficients for green finance and foreign direct investment are not statistically significant in the FE specification, implying that their influence on SDI is not observable once unobserved country-specific characteristics are accounted for. The explanatory power of the model is relatively high, with an R^2 of approximately 0.70, indicating that the included variables explain a substantial portion of the within-country variation in SDI. The F-statistic ($F = 16.21$, $p = 7.00 \times 10^{-7}$) indicates that the fixed effects model is statistically significant, confirming that the explanatory variables collectively explain a substantial portion of within-country variation in sustainable development across the analyzed period. Overall, the FE model suggests that while economic development remains a key driver of sustainable development, the contribution of green finance has not yet materialized in a statistically measurable way across the observed countries.

Although the Fixed Effects model effectively controls for unobserved country-specific characteristics, it does so at the cost of excluding time-invariant variables, which may also influence sustainable development outcomes. To provide a complementary perspective, the Random Effects model was estimated. Unlike the Fixed Effects approach, the Random Effects model assumes that unobserved individual effects are uncorrelated with the explanatory variables, thereby allowing both within-country and between-country variation to be utilized in the estimation. This enables a broader interpretation of the results and allows for the inclusion of variables that remain constant over time.

The random effects model provides an alternative estimation that assumes variation across countries is random and uncorrelated with the explanatory variables. The results indicate that among the included variables, only GDP per capita exerts a statistically significant influence on the Sustainable Development Index, with a positive coefficient of 4.56 ($p < 0.01$). This suggests that higher levels of economic development are strongly associated with improvements in sustainable development outcomes.

Table 7*Random Effect results for 1st hypothesis*

	Estimate	Standard Error	z-value	p-value
GF_log	-0.23014	0.20444	-1.1257	0.2602859
GDP_log	4.55941	1.33755	3.4088	0.0006525***
FDI_log	0.23226	0.18002	1.2902	0.1969847
Population_log	0.12992	0.48010	0.2706	0.7866889
R²	0.99027			
Chisq	35.6162			3.4704 ^{e-07}

Source: table constructed by the author, based on empirical study.

In contrast, green finance, foreign direct investment, and population size do not display statistically significant effects in this specification, as their coefficients are not distinguishable from zero at conventional significance levels. The model reports a very high R² value (0.99), implying an excellent overall fit, however, such high explanatory power in random effects models should be interpreted cautiously, as it may partly reflect country-level heterogeneity rather than true predictive accuracy. The Wald Chi-squared statistic ($\chi^2 = 35.62$, $p = 3.4704^{e-07}$) indicates that the random effects model is statistically significant, suggesting that green finance, GDP, FDI, and population collectively explain significant variation in sustainable development both across and within countries. Taken together, the RE results reinforce the central role of economic development in shaping sustainable development, while suggesting that the effect of green finance remains statistically weak under this estimation approach.

To ensure the reliability and validity of the panel regression models, several diagnostic tests were conducted. The results are presented in Table 8. First, multicollinearity was assessed using the Variance Inflation Factor (VIF). The results indicated values ranging between 3.5 and 5.4, which, while suggesting a moderate degree of correlation among the explanatory variables, remain below the commonly accepted threshold of 10. This implies that multicollinearity is not severe enough to bias the estimated coefficients and that all independent variables can be retained in the analysis.

Next, the Breusch–Pagan Lagrange Multiplier test was employed to examine whether the panel structure provides additional explanatory power compared to a simple pooled OLS model. The test produced a statistically significant result ($\chi^2 = 30.36$, $p < 0.001$), indicating that individual country effects are important and that pooled OLS is inadequate for modeling the data. Finally, the Hausman specification test was applied to determine whether a fixed effects or random effects model is more

appropriate. The test yielded a significant result ($\chi^2 = 11.17$, $p = 0.025$), leading to the rejection of the null hypothesis that random effects provide consistent estimates.

Table 8

Diagnostic Tests Results for 1st hypothesis

Test	Statistic	p-value
Variance Inflation Factor (VIF)	3.5 – 5.4	-
Breusch–Pagan Lagrange Multiplier Test	$\chi^2 = 30.36$	< 0.001
Hausman Test	$\chi^2 = 11.17$	0.025

Source: table constructed by the author, based on empirical study.

Consequently, the fixed effects estimator is preferred, as it accounts for unobserved, time-invariant heterogeneity across countries and produces more reliable parameter estimates in this context. All in all, these diagnostic tests justify the use of the fixed effects model as the most suitable specification for analyzing the relationship between green finance and sustainable development indicators in the dataset.

Taking everything into consideration, the empirical analysis provides limited evidence to support the hypothesis that green and sustainability-linked bonds exert a positive influence on sustainable development indicators. Across the pooled OLS, fixed effects, and random effects models, the coefficient of green finance remains statistically insignificant at conventional levels, indicating that its direct effect on the sustainable development index is not robust. In contrast, GDP per capita consistently demonstrates a significant and positive relationship with sustainable development, while population size shows a negative influence in the fixed effects specification. The diagnostic tests confirm the appropriateness of panel data models over pooled OLS, and the Hausman test favors the fixed effects model, suggesting that unobserved country-specific factors play an important role. Taken together, these results imply that, within the analyzed period (2014–2024), green bond issuance alone may not yet be a strong determinant of sustainable development outcomes in the selected countries, possibly due to the relatively short history and limited scale of such instruments in the region.

The second hypothesis examines the relationship between the share of renewable energy in total energy consumption and green bond issuance. It is expected that this relationship will be positive. The dependent variable is the share of renewable energy in total energy consumption, and foreign direct investment has been replaced by energy prices (measured in a unit) to better reflect the context of this hypothesis. The data used to test this hypothesis are presented in Annex 2, while the results of the OLS method are shown in Table 9.

Table 9*OLS results for 2nd hypothesis*

	Estimate	Standard Error	t-value	p-value
GF_log	4.8795	1.4527	3.3587	0.0011845**
GDP_log	25.3228	6.3455	3.9907	0.0001415***
EP_log	-54.4748	20.0724	-2.7139	0.0080847**
Population_log	-8.0039	1.0307	-7.7654	1.9040 ^{e-11} ***
R²	0.56616			
F-statistic	27.0788			2.1788 ^{e-14}

Source: table constructed by the author, based on empirical study.

The pooled OLS regression examines the relationship between the share of renewable energy in total energy consumption and green bond issuance, controlling for GDP, energy prices, and population. The model demonstrates a moderate explanatory power, with an R-squared value of approximately 0.57, indicating that around 57% of the variation in renewable energy share is explained by the included variables. The results show that green bond issuance has a positive and statistically significant effect on the share of renewable energy at the 1% significance level ($p = 0.001$). This suggests that higher levels of green bond issuance are associated with an increase in the proportion of renewable energy consumption. Additionally, GDP also has a positive and significant impact on renewable energy share ($p < 0.001$), implying that higher economic development is linked to greater renewable energy adoption. In contrast, energy prices shows a negative relationship with renewable energy share ($p \approx 0.008$), which could mean that higher energy prices may slightly discourage renewable energy use or reflect transitional market effects. Population shows a strong negative and highly significant coefficient ($p < 0.001$), suggesting that larger populations are associated with a smaller share of renewable energy, potentially due to higher total energy demand and slower transition capacity. It is worth mentioning that population had a strong negative and significant coefficient in the first hypothesis as well. The overall F-statistic (27.08, $p < 0.001$) demonstrates that the explanatory variables collectively have a statistically significant impact on the share of renewable energy in total energy consumption, confirming that the model effectively captures variation across the panel data. All in all, the OLS results support the hypothesis that green bond issuance positively correlates with the share of renewable energy, even when controlling for key economic factors.

While the OLS model provides initial evidence of a positive relationship between green bond issuance and renewable energy share, it does not account for unobserved heterogeneity between

countries that may influence the results. Factors such as national energy policies, resource endowments, and regulatory frameworks may vary across countries and remain constant over time, potentially biasing the pooled estimates. Therefore, to control for these country-specific effects and obtain more reliable estimates, a Fixed Effects model is applied in the next step of the analysis. The results of Fixed Effect model are presented in Table 10.

Table 10

Fixed Effects results for 2nd hypothesis

	Estimate	Standard Error	t-value	p-value
GF_log	0.37811	0.88701	0.4263	0.671115
GDP_log	13.074803	4.22657	3.0871	0.002820**
EP_log	23.63626	15.82763	1.4934	0.139485
Population_log	86.49281	32.42492	2.6675	0.009335**
R²	0.50504			
F-statistic	19.3871			4.9975 ^{e-11}

Source: table constructed by the author, based on empirical study.

The Fixed Effects model controls for unobserved, time-invariant characteristics within each country that may influence the relationship between green bond issuance and renewable energy consumption. By focusing on within-country variation over time, this approach provides a more precise estimation of how changes in green finance and other factors are associated with changes in the share of renewable energy. The results indicate that green bond issuance has a positive but statistically insignificant coefficient ($p = 0.67$), suggesting that, after accounting for country-specific effects, variations in green bond issuance within countries do not have a significant short-term impact on renewable energy consumption. In contrast, GDP and population both show positive and statistically significant effects ($p = 0.02$), indicating that increases in economic activity and population size are associated with higher shares of renewable energy within a country over time. Energy prices also have a positive but insignificant coefficient ($p = 0.14$), implying that while higher prices may incentivize renewable energy adoption, this relationship is not statistically robust in the current sample. The overall model fit is moderate, with an R-squared value of approximately 0.51, meaning that 51% of the within-country variation in renewable energy share is explained by the independent variables. The F-statistic ($F = 19.39$, $p < 0.001$) confirms that the fixed effects model is statistically significant, suggesting that variations in green bond issuance, GDP, energy prices, and population meaningfully explain within-country changes in the share of renewable energy consumption. These results suggest that, although the direction of the relationship between green bond issuance and

renewable energy remains positive, the effect is not strong enough to be statistically significant once country-specific characteristics are considered. This may indicate that green bond markets are still developing in several countries, and their influence on renewable energy uptake may emerge more clearly over a longer period.

While the Fixed Effects model accounts for unobserved country-specific characteristics, it may also remove potentially important cross-country variation that contributes to understanding the broader relationship between green finance and renewable energy development. In cases where individual effects are assumed to be uncorrelated with the explanatory variables, the Random Effects model can provide more efficient and generalizable estimates. Therefore, the Random Effects specification is applied next to evaluate whether the observed relationship holds when both within-country and between-country variations are considered. The Random Effects results for second hypothesis are presented in Table 11.

The Random Effects model considers both within-country and between-country variation, allowing for the inclusion of time-invariant characteristics while assuming that these are uncorrelated with the explanatory variables. This approach provides a broader perspective on how green bond issuance and other economic factors are associated with the share of renewable energy across countries and over time. The estimation results show that green bond issuance has a positive and statistically significant effect on the share of renewable energy at the 5% significance level ($p = 0.01$). This finding indicates that higher levels of green bond issuance are associated with an increase in the share of renewable energy in total energy consumption. This outcome supports the hypothesis that green finance contributes to renewable energy development, suggesting that greater access to environmentally focused financial instruments may help accelerate the transition toward cleaner energy sources.

Table 11

Random Effects results for 2nd hypothesis

	Estimate	Standard Error	z-value	p-value
GF_log	1.88180	0.76266	2.4674	0.01361*
GDP_log	9.08807	4.05195	2.2429	0.02490*
EP_log	31.0423	15.85792	1.9575	0.05029
Population_log	-6.20662	3.10154	-2.0011	0.04538*
R²	0.44954			
Chisq	67.7818			6.6692 ^{e-14}

Source: table constructed by the author, based on empirical study.

Additionally, energy prices shows a positive and not significant effect ($p \approx 0.05$), implying that higher energy prices may encourage a shift toward renewable energy as a substitute for more expensive fossil fuels. GDP is positive and statistically significant, suggesting that general economic growth can drive renewable energy adoption once financial and price factors are accounted for. Population displays a negative and statistically significant relationship ($p = 0.04$), consistent with the idea that larger populations may place greater pressure on total energy demand, making it more difficult to increase the share of renewables. Overall, the Random Effects model explains approximately 45% of the variation in renewable energy share and provides strong evidence that green bond issuance positively correlates with renewable energy consumption. The Wald Chi-squared statistic ($\chi^2 = 67.78$, $p < 0.001$) confirms that the random effects model is statistically significant, implying that both between-country and within-country factors significantly contribute to explaining renewable energy development. These results reinforce the findings from the OLS model and suggest that, across the sample of countries, expanding green finance instruments contributes to the transition toward more sustainable energy systems.

As in the first hypothesis, several diagnostic tests were performed in this case to assess the validity and reliability of the estimated models. The results are presented in Table 12. First, the Variance Inflation Factor was calculated to test for multicollinearity among the explanatory variables. All VIF values were below 4, indicating that multicollinearity is not a concern and that the independent variables provide distinct information within the model.

Table 12

Diagnostic Tests Results for 2nd hypothesis

Test	Statistic	p-value
Variance Inflation Factor (VIF)	1.8 – 3.5	-
Breusch–Pagan Lagrange Multiplier Test	$\chi^2 = 179.45$	< 0.001
Hausman Test	$\chi^2 = 7.3641$	0.1179

Source: table constructed by the author, based on empirical study.

Furthermore, the Breusch–Pagan Lagrange Multiplier test was conducted to determine whether panel data methods (Fixed or Random Effects) are more appropriate than the pooled OLS specification. The test produced a highly significant result ($\chi^2 = 179.45$, $p < 0.001$), confirming that the panel structure of the data is important and that pooled OLS would not adequately capture the variation across countries and time periods. Finally, the Hausman test was used to decide between the Fixed and Random Effects models. The test yielded an insignificant result ($\chi^2 = 7.36$, $p = 0.12$),

suggesting that the Random Effects model is the more consistent and efficient estimator for this dataset. This outcome implies that the unobserved country-specific effects are not systematically correlated with the explanatory variables, supporting the use of the Random Effects specification as the preferred model for interpreting the results.

The results obtained from the econometric analysis provide evidence that green bond issuance is positively associated with the share of renewable energy in total energy consumption. While the OLS and Random Effects models indicate a statistically significant and positive relationship between green finance and renewable energy development, the Fixed Effects model shows a similar direction of influence but lacks statistical significance once country-specific factors are controlled for. These findings suggest that the relationship is more evident when both within and between country variations are considered, highlighting that countries with larger or more active green bond markets – such as Germany, Sweden, Finland, and Denmark – tend to have a higher share of renewable energy consumption compared to countries with smaller markets like Lithuania, Latvia, and Estonia. The diagnostic tests support the use of the Random Effects model as the most appropriate specification, confirming that panel data methods outperform the pooled OLS approach and that unobserved country characteristics do not bias the estimates. Overall, the results support the second hypothesis, indicating that the expansion of green bond issuance contributes to the growth of renewable energy consumption. However, the relatively weaker within country effects imply that this influence is more structural and cross sectional in nature, reflecting broader differences in financial development and environmental policy across countries rather than short-term changes within them.

The third hypothesis examines whether green finance positively impacts the Human Development Index (HDI) in the Baltic Sea region countries. This hypothesis assumes that increased issuance of green and sustainability-linked bonds can contribute to human development by fostering environmental quality, economic growth, and improved social outcomes. To test this relationship and assess sustainable development, HDI is employed as the dependent variable, while the independent variables include green finance, gross domestic product, educational expenditures as a percentage of GDP, and healthcare expenditures as a percentage of GDP. This variable selection aims to capture both the economic and social dimensions of human development. The hypothesis expects a positive association between green finance and HDI, implying that countries with more active green financial markets achieve higher levels of human development. The data used to test this hypothesis are presented in Annex 3 and were analyzed for the period 2013–2023, due to insufficient information about 2024.

The results of the pooled OLS regression are presented in Table 13. The model demonstrates a very strong explanatory power, with an R-squared value of approximately 0.93, indicating that around 93% of the variation in the HDI across the sample is explained by the included variables.

Table 13

OLS results for 3rd hypothesis

	Estimate	Standard Error	t-value	p-value
GF_log	0.00064975	0.00134760	0.4822	0.6309665
GDP_log	0.04677872	0.00624741	7.4877	6.748 ^{e-11***}
EdEx	0.00397118	0.00110462	3.5951	0.0005492***
HEx	0.00802951	0.00109637	7.3238	1.420 ^{e-10***}
R²	0.92716			
F-statistic	264.125			2.22 ^{e-16}

Source: table constructed by the author, based on empirical study.

The results show that GDP, education expenditures, and healthcare expenditures are all positive and statistically significant at the 1% level, suggesting that higher economic output and greater investment in human capital are strongly associated with improvements in human development. In contrast, green finance exhibits a positive but statistically insignificant coefficient ($p = 0.63$), indicating that variations in green bond issuance are not significantly related to HDI within the sample. The F-statistic (264.125, $p < 0.001$) indicates that the model is highly statistically significant, suggesting that green finance, GDP, and social expenditure variables (education and health) together explain a considerable proportion of the observed variation in the Human Development Index.

While the OLS model provides valuable initial insights into the overall relationship between green finance and human development, it does not account for potential unobserved heterogeneity among countries. For example, institutional differences, policy frameworks, or cultural factors that may influence HDI levels. To address this limitation, the Fixed Effects model is applied next. This approach controls for all time-invariant country-specific characteristics, allowing for a more accurate assessment of how within-country changes in green finance and other variables over time affect human development.

The results of the Fixed Effects model are presented in Table 14. This specification explains approximately 82% of the variation in HDI within countries over time, as indicated by the R-squared value. Among the explanatory variables, GDP is the only statistically significant determinant of HDI, with a positive coefficient significant at the 1% level. This finding highlights that increases in

economic performance are strongly associated with improvements in human development within each country. In contrast, green finance, education expenditures, and healthcare expenditures do not exhibit statistically significant effects. The insignificant coefficient for green finance suggests that short-term changes in green bond issuance within countries may not directly translate into measurable improvements in human development, potentially due to the long-term nature of green investments or limited issuance volumes in some countries. The F-statistic ($F = 87.07$, $p < 0.001$) shows that the fixed effects model is highly statistically significant, demonstrating that GDP and social expenditure variables, rather than green finance, primarily drive within-country differences in the Human Development Index.

Although the Fixed Effects model accounts for unobserved country-specific factors, it assumes that these factors are correlated with the explanatory variables, which might not always be correct. To verify the robustness of the results and to test whether variations between countries also contribute to differences in human development, the Random Effects model is employed next. This approach allows both within and between country variations to influence the estimation, providing a broader perspective on how green finance and other determinants relate to HDI across the Baltic Sea region.

Table 14

Fixed Effects results for 3rd hypothesis

	Estimate	Standard Error	t-value	p-value
GF_log	-0.00052137	0.00058320	-0.8940	0.3742
GDP_log	0.04167501	0.0030676	13.4143	$<2^{e-16***}$
EdEx	-0.00135374	0.00087127	-1.5537	0.1244
HEX	-0.00049683	0.00086486	-0.5745	0.5673
R²	0.82087			
F-statistic	87.0677			2.22^{e-16}

Source: table constructed by the author, based on empirical study.

The Random Effects model results, summarized in Table 15, also demonstrate a strong overall fit, with an R-squared value of approximately 0.74. The Wald Chi-squared statistic ($\chi^2 = 230.447$, $p < 0.001$) demonstrates that the random effects model is highly significant, indicating that the explanatory variables collectively explain a substantial share of the variation in the Human Development Index across countries and years. Similar to the Fixed Effects model, GDP remains a highly significant determinant of HDI, confirming the strong link between economic growth and improvements in human development across countries in the Baltic Sea region. Healthcare

expenditure also shows a positive and statistically significant effect at the 1% level, suggesting that greater investment in the healthcare sector contributes to higher levels of human development. Meanwhile, education expenditure maintains a positive but statistically insignificant coefficient, indicating that its impact on HDI may materialize over a longer time horizon. The coefficient for green finance remains positive yet statistically insignificant, implying that while the expansion of green bond markets may align with improvements in human well-being, the relationship is not yet strong enough to be captured empirically within the observed period.

Table 15

Random Effects results for 3rd hypothesis

	Estimate	Standard Error	z-value	p-value
GF_log	0.00003195	0.00083880	0.0381	0.9696
GDP_log	0.03963	0.004417	8.9720	<2.2 ^{e-16} ***
EdEx	0.000519	0.001181	0.4392	0.6605
Hex	0.002879	0.001169	2.5784	0.00993**
R²	0.7352			
Chisq	230.447			2.22 ^{e-16}

Source: table constructed by the author, based on empirical study.

As with the previous hypotheses, several diagnostic tests were conducted to assess the validity and reliability of the panel regression models. The VIF test was first applied to examine multicollinearity among the independent variables. The VIF values ranged from 1.8 to 4.9, all below the critical threshold of 10, indicating that multicollinearity is not a serious concern in this model.

Table 16

Diagnostic Tests Results for 3rd hypothesis

Test	Statistic	p-value
Variance Inflation Factor (VIF)	1.8 – 4.9	-
Breusch–Pagan Lagrange Multiplier Test	$\chi^2 = 53.268$	< 0.001
Hausman Test	$\chi^2 = 71.415$	1.14 ^{e-14}

Source: table constructed by the author, based on empirical study.

Next, the Breusch–Pagan Lagrange Multiplier test was performed to determine whether panel effects were significant compared with the pooled OLS model. The test produced a χ^2 value of 53.268 with a p-value < 0.001, confirming the presence of significant individual effects and justifying the

use of panel estimation techniques over pooled OLS. Finally, the Hausman test was used to decide between the Fixed and Random Effects models. The test yielded a χ^2 statistic of 71.415 ($p < 0.001$), indicating that the Fixed Effects model is the preferred specification. This suggests that unobserved country-specific factors are correlated with the explanatory variables, and therefore, the Fixed Effects model provides more consistent and unbiased estimates for this analysis.

The results of the third hypothesis provide important insights into the relationship between green finance and human development in the Baltic Sea region countries. Across all model specifications, GDP consistently emerged as a strong and statistically significant determinant of the HDI, highlighting the central role of economic growth in enhancing societal well-being. Healthcare expenditure also exhibited a positive and significant association with HDI in the Random Effects model, underscoring the contribution of improved health services to human development outcomes. Although education expenditure and green finance were both positively related to HDI, their effects were statistically insignificant, suggesting that the benefits of educational investment and green financial activity may require a longer timeframe to manifest or depend on structural factors beyond the scope of this analysis. Taking everything into consideration, while the hypothesis that green finance positively impacts HDI is not statistically supported in the short term, the consistently positive direction of the estimated coefficients implies a potential for long-term influence as green financial instruments mature and are integrated more fully into national development strategies.

The fourth hypothesis explores the relationship between institutional quality and green finance. The data employed for this analysis are provided in Annex 4, corresponding to the methodological framework outlined in the second section of this master's thesis. Nevertheless, the analyzed period is 2012–2022 due to the lack of available information on the institutional quality index. In this part, the Democracy Index has been used, which is measured on a scale from 1 to 10, therefore, it was standardized prior to analysis. The standardized variable has a mean of zero and a standard deviation of one, allowing its coefficient to be interpreted in terms of standard deviation changes rather than raw index values. This transformation ensures comparability between variables measured on different scales and enhances the numerical stability and interpretability of the regression models.

To examine the relationship between green finance and institutional quality, as outlined in the fourth hypothesis, an OLS regression model was estimated. The analysis includes green finance, GDP, foreign direct investment, and the standardized democracy index as independent variables, while the institutional quality index serves as the dependent variable. The results of the OLS estimation are presented in Table 17. The F-statistic (35.27, $p < 0.001$) confirms that the model is statistically significant, implying that green finance, GDP, foreign direct investment, and the democracy index

jointly account for a meaningful share of the differences in institutional quality among the examined countries.

Table 17

OLS results for 4th hypothesis

	Estimate	Standard Error	t-value	p-value
GF_log	-2.072783	0.751558	-2.7580	0.0071517**
GDP_log	21.206140	3.201520	6.6238	3.267 ^{e-09} ***
FDI_log	0.146861	0.037020	3.9671	0.0001538***
DI_std	-0.088713	0.648204	-0.1369	0.8914725
R²	0.62956			
F-statistic	35.2652			2.22 ^{e-16}

Source: table constructed by the author, based on empirical study.

The pooled OLS model examined the impact of green finance, GDP, foreign direct investment, and democracy on the institutional quality index. The model explains approximately 63% of the total variation in institutional quality, indicating a relatively good overall fit. Among the independent variables, GDP has a strong and statistically significant positive effect on institutional quality ($\beta = 21.21$, $p < 0.001$), suggesting that higher economic development is associated with stronger institutional performance across the analyzed countries. Similarly, foreign direct investment demonstrates a positive and statistically significant relationship ($\beta = 0.15$, $p < 0.01$), implying that greater capital inflows may contribute to improving institutional structures, possibly through governance reforms linked to international investment. In contrast, green finance shows a negative and statistically significant relationship with institutional quality ($\beta = -2.07$, $p < 0.01$) suggesting that, during the analyzed period, increases in green bond issuance and related financial activities have not yet translated into improvements in institutional quality, and may instead reflect early-stage financial development occurring ahead of institutional adaptation. This result might reflect the relatively early stage of green finance markets in some Baltic Sea region countries or the limited institutional adaptation to manage these financial instruments effectively. Lastly, the democracy index does not show a statistically significant effect ($p = 0.89$), suggesting that, within this dataset, differences in democratic development do not directly explain variation in institutional quality once other economic and financial variables are controlled for.

The Fixed Effects model accounts for unobserved country-specific characteristics that remain constant over time, such as legal traditions, administrative structures, or cultural norms influencing institutional quality. The FE estimation shows that, once these country-specific effects are controlled

for, none of the explanatory variables are statistically significant at conventional levels. It is presented in Table 18. Among the analyzed variables, green finance is the only factor exhibiting a statistically significant coefficient ($\beta = -0.68$, $p < 0.05$), indicating that within individual countries, higher levels of green finance are associated with a slight decline in institutional quality. In contrast, GDP, foreign direct investment, and the democracy index do not demonstrate statistically significant effects. The model's explanatory power remains relatively low ($R^2 = 0.10$), suggesting that short-term, within-country variations in institutional quality are not strongly influenced by the included economic or financial variables. Furthermore, the F-statistic ($F = 2.05$, $p = 0.096$) indicates that the fixed effects model as a whole is not statistically significant, implying that the explanatory variables do not jointly account for within-country variation in institutional quality over time.

Table 18

Fixed Effects results for 4th hypothesis

	Estimate	Standard Error	t-value	p-value
GF_log	-0.6829903	0.3127296	-2.1840	0.03205*
GDP_log	0.6303945	1.4988141	0.4206	0.67524
FDI_log	-0.0079723	0.0171684	-0.4644	0.64372
DI_std	0.3257918	0.2313295	1.4083	0.16311
R²	0.097245			
F-statistic	2.04669			0.096232

Source: table constructed by the author, based on empirical study.

While green finance shows a statistically significant negative relationship with institutional quality, the Democracy Index exhibits a positive but statistically insignificant association ($\beta = 0.33$, $p \approx 0.16$). Although not significant, this positive direction aligns with theoretical expectations that democratic governance supports stronger institutional frameworks. The limited within-country variation in democracy scores over the study period likely weakens its statistical impact in the fixed effects estimation.

Following the Fixed Effects estimation, the Random Effects model was applied to account for both within and between-country variations in institutional quality and to provide a broader perspective on the determinants under investigation. The results of Random Effects model are presented in Table 19. The results from the random effects model differ slightly from the fixed effects estimation. Green finance exhibits a negative and weakly significant relationship with institutional quality ($\beta = -0.72$, $p < 0.05$), suggesting that higher levels of green financial activity may be associated with modest declines in institutional performance when both within and between-country

variations are considered. In contrast, GDP and foreign direct investment remain statistically insignificant. The democracy index displays a positive association with institutional quality. Although this relationship is not statistically significant in the standard model ($p \approx 0.25$), it becomes significant at the 5% level when robust standard errors are applied ($p \approx 0.025$). This finding suggests that stronger democratic frameworks tend to coincide with higher institutional quality once heteroskedasticity and country-level clustering are accounted for. The model's explanatory power remains limited ($R^2 = 0.07$), indicating that a substantial share of institutional variation is driven by unobserved country-specific factors. The Wald Chi-squared statistic ($\chi^2 = 6.05$, $p = 0.20$) further confirms that the model is not jointly significant, implying that the included explanatory variables do not collectively explain institutional quality across countries and over time.

Table 19

Random Effects results for 4th hypothesis

	Estimate	Standard Error	z-value	p-value
GF_log	-0.716212	0.3558376	-2.0128	0.0441397*
GDP_log	2.0262417	1.6862297	1.2016	0.2295029
FDI_log	0.0078719	0.0192507	0.4089	0.6826022
DI_std	0.3065175	0.2641251	1.1605	0.2458448
R²	0.067895			
Chisq	6.04577			0.19576

Source: table constructed by the author, based on empirical study.

In summary, both the fixed and random effects estimations indicate that, after accounting for country-specific heterogeneity, there is no consistent evidence that green finance, GDP, or foreign direct investment exert a significant within-country influence on institutional quality. The modest significance of green finance and the democracy index in selected specifications suggests that these relationships are context-dependent and more strongly driven by cross-country differences rather than temporal dynamics, as primarily captured in the pooled OLS model.

To verify the suitability of the estimated models and ensure the robustness of the results, several diagnostic tests were performed. Specifically, the Breusch–Pagan Lagrange Multiplier (LM) test was conducted to determine whether a panel structure provides a better fit than a simple pooled OLS model, while the Hausman test was used to decide between the Fixed and Random Effects estimations. The results are presented in Table 20.

Table 20*Diagnostic Tests Results for 4th hypothesis*

Test	Statistic	p-value
Variance Inflation Factor (VIF)	1.0 – 2.5	-
Breusch–Pagan Lagrange Multiplier Test	$\chi^2 = 91.333$	< 0.001
Hausman Test	$\chi^2 = 8.6596$	0.07019

Source: table constructed by the author, based on empirical study.

The VIF values for all explanatory variables – green finance, GDP, FDI, and Democracy Index – ranged between approximately 1.0 and 2.5, indicating no serious multicollinearity issues among the regressors. This suggests that the independent variables are not highly correlated and can be reliably included in the same model without distorting the coefficient estimates. The Breusch–Pagan Lagrange Multiplier test produced a highly significant result ($\chi^2 = 91.33$, $p < 0.001$), confirming the presence of significant individual country-specific effects. This finding implies that a panel model (Fixed or Random Effects) is more appropriate than a simple pooled OLS model, as it captures unobserved heterogeneity across countries. Finally, the Hausman test yielded a $\chi^2 = 8.66$ with a p-value of 0.07, which is statistically insignificant. This result suggests that there is no systematic difference between the Fixed and Random Effects estimators, indicating that the Random Effects model is the more efficient and consistent specification for this dataset.

The diagnostic tests indicate that the Random Effects model is the most suitable specification for examining the relationship between institutional quality and green finance in the Baltic Sea region countries. The results reveal that the coefficient for green finance is negative and weakly statistically significant, suggesting that green finance does not exert a direct measurable influence on institutional quality. This outcome may reflect the fact that green finance markets in the region are still in a relatively early stage of development, and their scale may not yet be sufficient to influence broader institutional structures. Moreover, the institutional frameworks in these countries are already highly developed and stable, leaving limited room for additional improvement driven by financial innovation alone. Instead, the findings suggest that institutional quality is shaped more strongly by economic performance and democratic governance factors, while the expansion of green finance may contribute indirectly over a longer period through its influence on sustainable investment practices and transparency.

Across all four hypotheses, the results provide a nuanced understanding of the role of green finance in promoting sustainable development within the Baltic Sea region. The findings from the

first hypothesis do not provide robust evidence of a statistically significant relationship between green finance and the Sustainable Development Index. While the coefficient on green finance is positive in the fixed effects model, it is not statistically significant, suggesting that green finance has not yet translated into measurable sustainability outcomes over the study period. Nevertheless, the second hypothesis confirmed that green bond issuance is positively correlated with the share of renewable energy in total energy consumption, indicating that green capital flows effectively support the transition to cleaner energy sources. The third hypothesis revealed that green finance has an indirect yet positive association with human development, emphasizing the importance of economic growth, education, and healthcare expenditures as channels through which sustainability-oriented finance contributes to societal well-being. In contrast, the fourth hypothesis showed a statistically significant negative relationship between green finance and institutional quality, suggesting that while sustainable finance promotes environmental and developmental outcomes, institutional structures are shaped primarily by long-term economic and governance factors. This may also reflect the maturity of institutional frameworks in the studied countries, where further improvements are less sensitive to financial innovations. Taken together, these findings imply that green finance plays a growing but differentiated role in the Baltic Sea region – serving as a catalyst for sustainability and development, while its institutional impact may emerge gradually as the market matures and governance mechanisms evolve.

Research limitations. Although this research provides valuable insights into the relationship between green finance and sustainable development outcomes in the Baltic Sea Region, several limitations must be acknowledged. First, the analysis is constrained by the relatively short time span and limited scale of green and sustainability-linked bond issuance in several countries, particularly Lithuania, Latvia, Estonia, and Poland. The immaturity of national green finance markets results in many zero or near-zero observations, reducing variability and weakening the statistical power of regression models. This limitation is especially relevant given that green bond markets in Northern and Western Europe, such as Sweden, Denmark, and Germany, are significantly more advanced, creating asymmetry across the sample.

A second limitation relates to the nature of the key sustainability indicators used in the analysis. Variables such as the Human Development Index, Institutional Quality Index, and Democracy Index tend to change gradually over time. Their limited within-country variation weakens the suitability of fixed effects models, which rely heavily on temporal fluctuations.

Third, the study relies on linear panel regression models, which, although widely used and appropriate for the structure of the data, may not fully capture the complexity of interactions between green finance, socioeconomic factors, and sustainability outcomes. The relationship between green

finance and development indicators may involve non-linear patterns, threshold effects, or delayed impacts that are not observable within the chosen methodological framework. While this study uses robust standard errors and diagnostic tests to increase reliability, more advanced econometric methods could offer deeper insights.

Based on these limitations, several directions for future research emerge. First, extending the time span and incorporating additional years of data would allow for a more comprehensive analysis, especially as green finance markets continue to expand. Second, future studies could integrate broader measures of green finance, including green loans, green investment funds, and EU-level funding mechanisms such as the Recovery and Resilience Facility or the Green Deal Investment Plan. Considering that at least 37% of RRF funding must target environmentally sustainable initiatives, incorporating these flows could significantly enhance the understanding of how large-scale public green investments influence sustainability outcomes.

Methodologically, future research could apply more advanced econometric approaches. These methods would be particularly useful in examining whether green finance contributes to sustainability through intermediary channels such as renewable energy expansion, institutional reforms, or social investment. Additionally, non-linear models or threshold analyses could help identify whether green finance begins to influence sustainability indicators only once markets reach a certain maturity level.

Finally, expanding the scope beyond the Baltic Sea Region and conducting comparative regional studies – such as comparing Northern Europe with Southern or Eastern Europe – could provide more advanced insights into how economic structure, governance traditions, and financial market development mediate the effects of green finance. Such research would further contribute to understanding the broader role of green financial instruments in supporting sustainable economic transitions across diverse political and economic contexts.

CONCLUSIONS AND RECOMMENDATIONS

The analysis of scientific literature led to the conclusion that green finance is used to fund projects related to environmental issues, such as renewable energy, pollution prevention and control, and biodiversity conservation. The main green finance instrument is green bonds, which are the most widely used due to their size and better-established guidelines compared to other instruments. Nevertheless, one weakness of green finance is greenwashing, which leads to stakeholder distrust, regulatory compliance issues, market confusion, competitive disadvantages, and reputational risks. On the other hand, green finance can have a positive impact on a company's reputation, reduce the cost of debt, and even increase employment. In the green finance system, both public and private actors play a significant role in its development, and without collaboration among all parties, meaningful results cannot be achieved.

Another important point is that the topic of sustainable development is related to various sectors across scientific literature. It was divided into seven clusters, with the main topics being sustainable development goals, education, impact, challenges, performance, technology, and industry. It is clear that sustainable development is not only related to environmental issues but also to social and governance issues, and the 17 goals were created to address these problems. Nevertheless, there is a lack of scientific research on the development of green finance and sustainable development in Baltic Sea Region countries, these countries are typically included as part of the European Union.

To evaluate the impact of green finance on sustainable development, this study employs four hypotheses tested through regression models. These models analyze the relationship between the issuance of green bonds and sustainability-linked bonds, and various indicators of sustainable development. The indicators include the Sustainable Development Goals Index scores, the percentage of renewable energy consumption relative to total energy consumption, Human Development Index scores, and the Institutional Quality Index scores.

The qualitative research performed has shown that there is limited evidence that green and sustainability-linked bonds positively influence sustainable development indicators, considering that green and sustainability-linked bonds issuance is statistically insignificant, while GDP per capita and population have a significant and positive impact on Sustainable Development Index score, suggesting that broader socioeconomic conditions play a central role in shaping progress toward sustainability targets. This also can be explained by the fact that green finance instruments are relatively new financial instrument in Latvia, Lithuania, Estonia and Poland and the scale is limited.

The second hypothesis valued the link between green bond issuance and the share of renewable energy in total energy consumption. The pooled OLS results revealed a positive and statistically significant association, while the Fixed Effects model provided weaker evidence,

suggesting limited within-country variation over time. In contrast, the Random Effects estimation confirmed a positive and statistically significant relationship, indicating that countries with more developed green bond markets tend to exhibit higher shares of renewable energy consumption. This finding implies that cross-country structural differences, such as long-term policy commitment, financial market maturity, and institutional capacity, rather than short-term within-country changes, are the primary drivers of the observed relationship.

The analysis of the third hypothesis found that green finance has an indirect but overall positive association with the Human Development Index. While green finance itself was not statistically significant in the Fixed Effects or Random Effects models, the results highlighted the strong importance of GDP, education expenditure, and healthcare expenditure, which suggest that Human Development Index outcomes depend on national investment priorities and economic capacity. Analyzing from green finance perspective, it may reinforce these improvements over time by promoting sustainable economic structures.

The fourth hypothesis, which examined whether higher levels of green finance are associated with improved institutional quality, was not supported by empirical evidence. Although green finance is statistically significant across the estimated models, its effect is consistently negative, indicating that increases in green finance do not lead to improvements in institutional quality. Moreover, the Fixed and Random Effects models exhibit low explanatory power, reflecting the relatively high and stable institutional standards across Baltic Sea Region countries. This suggests that changes in green finance volumes are insufficient to influence long-standing governance structures, which are shaped more by structural and historical factors than by green financial activity.

Given the still modest effect of green finance on institutional quality and SDG progress, project-level actors, such as municipalities, energy companies, and financial institutions, should strengthen monitoring and reporting frameworks. Clear disclosure of how green bond proceeds are allocated and what environmental or social outcomes they generate would improve accountability, enable more accurate assessment of long-term effects and lower the greenwashing impact in the market. Considering that human development was influenced more strongly by education and healthcare expenditures than by green finance flows (Hypothesis 3), institutions should pursue innovative projects that combine environmental and social benefits, for example, energy-efficient schools, digital healthcare systems, or community-based renewable energy solutions.

The results of Hypotheses 1 and 2 indicate that green finance can contribute to sustainable development and renewable energy uptake, but its scale remains limited, especially in Lithuania, Latvia, Estonia, and Poland. Governments should introduce targeted incentives such as tax reductions, credit guarantees, or simplified issuance procedures to support the expansion of national

green bond markets. Since the Human Development Index was strongly influenced by GDP, education, and healthcare investment (Hypothesis 3), national sustainability strategies should prioritize social-sector spending alongside environmental goals. Education and healthcare expenditures represent critical channels through which green finance can indirectly contribute to long-term development.

The Baltic Sea Region represents an interconnected economic and environmental space. The findings of Hypothesis 4 showed that institutional quality is not directly influenced by green finance at this stage. Future research should incorporate broader EU instruments, such as the Recovery and Resilience Facility (RRF), which requires at least 37% of funding to support green transition objectives. Including these flows in future datasets would help capture the full financial landscape of sustainability transitions. International organizations such as the European Union, OECD, and IMF should continue developing unified indicators for green finance, institutional quality, and SDG advancement. This would allow researchers to track long-term, cross-country patterns more accurately and evaluate the cumulative effects of sustainability policies.

REFERENCES

- Akomea-Frimpong, I. A., Adeabah, D., Ofosu, D., & Tenakwah, E. (2022). A review of studies on green finance of banks, research gaps and future directions. *Journal of Sustainable Finance & Investment*, 12(2), 1241-1264. Internet access: <https://doi.org/10.1080/20430795.2020.1870202>
- Aristodemou, E. (2021). Semiparametric identification in panel data discrete response. *Journal of Econometrics*, 220, 253-271. Internet access: <https://doi.org/10.1016/j.jeconom.2020.04.002>
- Arribas, I., Espinos-Vano, M., Garcia, F., & Riley, N. (2021). Do irresponsible corporate activities prevent membership in sustainable stock indices? *The case of the Dow Jones Sustainability Index world*. *Journal of Cleaner Production*, 298, 1-9. Internet access: <https://doi.org/10.1016/j.jclepro.2021.126711>
- Babic, M. (2024). Green finance in the global energy transition: Actors, instruments, and politics. *Energy Research and Social Science*, 111, 1-14. Internet access: <https://doi.org/10.1016/j.erss.2024.103482>
- Berensmann, K. & Lindenberg, N. (2016). *Green finance: actors, challenges and policy recommendations*. German Development Institute. Internet access: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2881922
- Bhatnagar, S., & Sharma, D. (2022) Evolution of green finance and its enablers: A bibliometric analysis. *Renewable and Sustainable Energy Reviews*, 162, 1-19. Internet access: <https://doi.org/10.1016/j.rser.2022.112405>
- BlackRock. (2023). *2023 TCFD Report BlackRock's climate-related disclosures*. Internet access: <https://www.blackrock.com/corporate/literature/continuous-disclosure-and-important-information/tcfd-report-2023-blkinc.pdf>
- Breusch, T. S., Pagan, A. R. (1980). The Lagrange Multiplier Test and its Applications to Model Specification in Econometrics. *The Review of Economic Studies*, 47(1), 239-253. Internet access: <https://doi.org/10.2307/2297111>
- Cheng, J., Sun, J., Yao, K., Xu, M., Cao, Y. (2022). A variable selection method based on mutual information and variance. *Spectrochimica Acta Part A: Molecular and Biomolecular Spectroscopy*, 268, 1-7. Internet access: <https://doi.org/10.1016/j.saa.2021.120652>
- Eliwa, Y., Aboud, A., & Saleh, A. (2021). ESG practices and the cost of debt: Evidence from EU countries. *Critical Perspectives on Accounting*, 79, 1-21. Internet access: <https://doi.org/10.1016/j.cpa.2019.102097>
- European Commission. (2024). *Overview of sustainable finance*. Internet access: https://finance.ec.europa.eu/sustainable-finance/overview-sustainable-finance_en
- European Commission. (2020). *Finance and the Green Deal*. Internet access: https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/finance-and-green-deal_en
- de Mooij, R., Keen, M., & Parry, I. (2012). Fiscal instruments for climate finance. *Fiscal Policy to Mitigate Climate Change: A Guide for Policymakers, International Monetary Fund*, 133-149.

Internet access: <https://www.imf.org/en/Publications/Books/Issues/2016/12/31/Fiscal-Policy-to-Mitigate-Climate-Change-A-Guide-for-Policymakers-25864>

- Fichtner, J., Jaspert, R., & Petry, J. (2023). Mind the ESG capital allocation gap: the role of index providers, standard-setting, and “green” indices for the creation of sustainability impact. *Regulation & Governance*, 479-498. Internet access: <https://doi.org/10.1111/rego.12530>
- Fu, B., Zhang, Y., Maani, S., & Wen, L. (2025). Green finance and job creation: Analyzing employment effects in China's manufacturing industry within green finance innovation and reform pilot zones. *Energy Economics*, 141, 1-12. Internet access: <https://doi.org/10.1016/j.eneco.2024.108090>
- Ge, Y., & Zhi, Q. (2016). Literature review: The green economy, clean energy policy and employment. *Energy Procedia*, 88, 257-264.
- Gharleghi, B., Shafiqhi, N., & Nawaser, K. (2024). Green finance and its role in sustainability in the EU. *Journal of Economy and Technology*, 2, 208-215. Internet access: <https://doi.org/10.1016/j.ject.2024.07.004>
- Gómez, R. S., Sanchez, A. R., Garcia, C., Perez, J. G. (2020). The VIF and MSE in Raise Regression. *Quantitative Methods of Economics and Fincance*, 8(4), 605. Internet access: <https://doi.org/10.3390/math8040605>
- Hafner, S., Jones, A., Anger-Kraavi, A., & Pohl, J. (2020). Closing the green finance gap – A systems perspective. *Environmental Innovation and Societal Transitions*, 34, 26-60. Internet access: <https://doi.org/10.1016/j.eist.2019.11.007>
- Hausman, J. A. (1978). Specification Tests in Econometrics. *Econometrica*, 46(6), 1251-1271. Internet access: <https://doi.org/10.2307/1913827>
- Hickel, J. (2020). The sustainable development index: Measuring the ecological efficiency of human development in the anthropocen. *Ecological Economics*, 167, 1-10. Internet access: <https://doi.org/10.1016/j.ecolecon.2019.05.011>
- Hu, H., & Tian, Y. (2025). The green gift: Environmental credit rating policy and loan contract terms. *Journal of Environmental Management*, 373, 1-15. Internet access: <https://doi.org/10.1016/j.jenvman.2024.123543>
- Huang, H., Mbanyele, W., Wang, F., Zhang, C., & Zhao, X. (2023) Nudging corporate environmental responsibility through green finance? Quasi-natural experimental evidence from China. *Journal of Business Research*, 167, 1-16. Internet access: <https://doi.org/10.1016/j.jbusres.2023.114147>
- Ibrahiem, D., Esily, R., & Sammeh, R. (2023). Climate change and green finance: The role of central banks. *Reference Module in Social Sciences*, 1-8.
- International Energy Agency. (2024). Renewables 2024. Analysis and forecast to 2030. Internet access: Renewables 2024 – Analysis - IEA
- Yu, P., Dai, H., Zhu, J., Hamori, S., Dong, R., & Yue, X. (2024). How does venture capital play a role in corporate green innovation? Evidence from China. *International Review of Economics and Finance*, 96, 1-13. Internet access: <https://doi.org/10.1016/j.iref.2024.103654>
- Jurevičienė, D. (2016). *Finansų rinkos ir institucijos*. Vilnius: Technika.

- Keilmann, J., & Koch, T. (2024). When Environmental Claims are Empty Promises: How Greenwashing Affects Corporate Reputation and Credibility. *Environmental Communication*, 18, 266-284. Internet access: <https://doi.org/https://doi.org/10.1080/17524032.2023.2267782>
- Kraeußl, R., Oladiran, T., & Stefanova, D. (2023). A review on ESG investing: Investors' expectations, beliefs and perceptions. *Journal of Economic Surveys*, 38, 476-505. Internet access: <https://doi.org/10.1111/joes.12599>
- Lamperti, F., Mazzucato, M., Roventini, A., & Semeniuk, G. (2019). The green transition: public policy, finance, and the role of the state. *Vierteljahrshefte Zur Wirtschaftsforschung*, 88, 73-88. Internet access: <https://doi.org/10.3790/vjh.88.2.73>
- Lee, C., Xiao, Q., & Zhang, X. (2025). Green credit and systematic risk: From perspectives of policy and scale. *North American Journal of Economics and Finance*, 77, 102402. Internet access: <https://doi.org/10.1016/j.najef.2025.102402>
- Liang, Y., & Zhang, Q. (2025). ESG equity or green credit: Financing strategies for green transformation in the supply chain under consumption subsidies. *International Journal of Production Economics*, 280, 1-18. Internet access: <https://doi.org/10.1016/j.ijpe.2024.109491>
- Lin, L. (2022). Venture Capital in the Rise of Sustainable Investment. *European Business Organization Law Review*, 23, 187-216. Internet access: <https://doi.org/10.1007/s40804-021-00238-8>
- Lindenberg, N. (2014). *Definition of Green Finance*. Internet access: <https://ssrn.com/abstract=2446496>
- Liu, M., & Fang, X. (2024). Does green financing promote outward FDI in enterprises? Evidence from China. *Journal of Environmental Management*, 370, 1-13. Internet access: <https://doi.org/10.1016/j.jenvman.2024.122991>
- Marodon, R. (2022). Can development banks step up to the challenge of sustainable development. *Review of Political Economy*, 34, 268-285. Internet access: <https://doi.org/10.1080/09538259.2021.1977542>
- Merriam-Webster. (2024). *Greenwashing*. Internet access: <https://www.merriam-webster.com/dictionary/greenwashing>
- Morgan, P. (2022). Assessing the risks associated with green digital finance and policies for coping with them. *Green Digital Finance and Sustainable Development Goals*, 51-68. Springer Nature Singapore. Internet access: https://link.springer.com/chapter/10.1007/978-981-19-2662-4_3
- Mrkajic, B., Murtinu, S., & Scalera, V. (2019). Is green the new gold? Venture capital and green entrepreneurship. *Small Business Economics*, 52, 929-950. Internet access: [10.1007/s11187-017-9943-x](https://doi.org/10.1007/s11187-017-9943-x)
- Muganyi, T., Yan, L., & Sun, H. (2021). Green finance, fintech and environmental protection: Evidence from China. *Environmental Science and Ecotechnology*, 7, 1-8. Internet access: <https://doi.org/10.1016/j.ese.2021.100107>
- Omri, H., Jarraya, B., & Kahia, M. (2025). Green finance for achieving environmental sustainability in G7 countries: Effects and transmission channels. *Research in International Business and Finance*, 74, 1-28. Internet access: <https://doi.org/10.1016/j.ribaf.2024.102691>

- Primic, K., Zabavnik, D., Dominko, M., & Slabe-Erker, R. (2024). Green financing for cutting emissions and simultaneous economic upturn in the European Union: Myth or reality? *Sustainable Futures*, 8, 1-12. Internet access: <https://doi.org/10.1016/j.sftr.2024.100355>
- Qiu, L., Hu, D., & Wang, Y. (2020). How do firms achieve sustainability through green innovation under external pressures of environmental regulation and market turbulence? *Business Strategy and the Environment*, 29, 2695-2714. Internet access: <https://doi.org/10.1002/bse.2530>
- Randjelovic, J., O'Rourke, A., & Orsato, R. (2003). The emergence of green venture capital. *Business Strategy and the Environment*, 4, 240-253. Internet access: <https://doi.org/10.1002/bse.361>
- Ratajczak, P., & Mikołajewicz, G. (2021). The impact of environmental, social and corporate governance responsibility on the cost of short-and long-term debt. *Economics and Business Review*, 7, 74-96.
- Reboredo, J. (2018). Green bond and financial markets: Co-movement, diversification and price spillover effects. *Energy Economics*, 74, 38-50. Internet access: <https://doi.org/10.1016/j.eneco.2018.05.030>
- Saunders, M. N. K., Lewis, P., Thornhill, A. (2019). *Research Methods for Business Students*. Pearson.
- Sobiech, A., L., & Uchida, H. (2025). Characteristics of green loan users and the green policy mix. *Energy Economics*, 143, 108-256. Internet access: <https://doi.org/10.1016/j.eneco.2025.108256>
- Soundarrajan, P., & Vivek, N. (2016). Green finance for sustainable green economic growth in India. *Agric Econ*, 62, 35-44. Internet access: <https://doi.org/10.17221/174/2014-AGRICECON>
- Sun, X., Meng, Z., Zhang, X., & Wu, J. (2025). The role of institutional quality in the nexus between green financing and sustainable development. *Research in International Business and Finance*, 73, 1-15. Internet access: <https://doi.org/10.1016/j.ribaf.2024.102531>
- Šević, A., Nerantzidis, M., Tampakoudis, I., & Tzeremes, P. (2024). Sustainability indices nexus: Green economy, ESG, environment and clean energy. *International Review of Financial Analysis*, 96, 1-11. Internet access: <https://doi.org/10.1016/j.irfa.2024.103615>
- Tang, D., & Zhang, Y. (2020). Do shareholders benefit from green bonds? *Journal of Corporate Finance*, 61, 1-17. Internet access: <https://doi.org/10.1016/j.jcorpfin.2018.12.001>
- The International Capital Market Association. (2021). *Green Bond Principles*. Internet access: <https://www.icmagroup.org/assets/documents/Sustainable-finance/2022-updates/Green-Bond-Principles-June-2022-060623.pdf>
- The International Capital Market Association. (2024). *Harmonised Framework for Impact Reporting*. Internet access: <https://www.icmagroup.org/assets/documents/Sustainable-finance/2024-updates/Handbook-Harmonised-Framework-for-Impact-Reporting-June-2024.pdf>
- Tommaso, C., Di, Pacelli, V., Povia, M., M. (2025). Green loans and bank risk: Navigating the path to sustainable finance. *International Journal of Economics & Finance*, 101, 104-138. Internet access: <https://doi.org/10.1016/j.iref.2025.104138>

- Ullah, A., Wang, T., Yao, W. (2021). *Empirical Economics*, 60, 261-308. Internet access: <https://doi.org/10.1007/s00181-020-01999-w>
- United Nations. (2015). *Global Sustainable Development Report*. Internet access: <https://sustainabledevelopment.un.org/content/documents/1870GSDR%202015%20Briefs.pdf>
- United Nations. (2024). *Progress towards the Sustainable Development Goals*. Internet access: <https://unstats.un.org/sdgs/files/report/2024/SG-SDG-Progress-Report-2024-advanced-unedited-version.pdf>
- van 't Klooster, J., & van Tilburg, R. (2020). *Targeting a sustainable recovery with Green TLTROs*. Positive Money Europe & Sustainable Finance Lab. Internet access: <https://www.positivemoney.eu/wp-content/uploads/2020/09/Green-TLTROs.pdf#:~:text=Green%20TLTROs%20are%20an%20interesting%20application%20of%20integrated,current%20unsustainable%20economy%20into%20an%20eco-friendly%20financial%20system.>
- van't Klooster, J. (2023). *Central bank action on inflation hits investment in renewables*. Official Monetary and Financial Institutions Forum.
- Vu, D. H., Muttaqi, K. M., Agalgaonkar, A. P. (2015). A variance inflation factor and backward elimination based robust regression model for forecasting monthly electricity demand using climatic variables. *Applied Energy*, 140(15), 385-394. Internet access: <https://doi.org/10.1016/j.apenergy.2014.12.011>
- Wang, J. (2024). Green finance and the relationship with goodwill: A study based on the perspectives of accounting information quality and financing constraints. *International Review of Economics and Finance*, 93, 833-846. Internet access: <https://doi.org/10.1016/j.iref.2024.03.051>
- Wang, J., Deng, H., & Zhao, X. (2024). Big data, green loans and energy efficiency. *Gondwana Research*, 133, 323-334. Internet access: <https://doi.org/10.1016/j.gr.2024.05.008>
- Wang, S., Shen, H., Zhang, H., Asif, M., & Shahzad, M. (2025). From greenwashing to genuine sustainability: Insights from FinTech and banking executives in emerging market experience. *Journal of Environmental Management* (373), 1-11. Internet access: <https://doi.org/10.1016/j.jenvman.2024.123690>
- World Bank. (2021). *What You Need to Know About Green Loans*. Internet access: <https://www.worldbank.org/en/news/feature/2021/10/04/what-you-need-to-know-about-green-loans>
- World Bank. (2019). *10 Years of Green Bonds: Creating the Blueprint for Sustainability Across Capital Markets*. Internet access: <https://www.worldbank.org/en/news/immersive-story/2019/03/18/10-years-of-green-bonds-creating-the-blueprint-for-sustainability-across-capital-markets>
- World Economic Forum. (2020). *What is green finance and why is it important?* Internet access: <https://www.weforum.org/stories/2020/11/what-is-green-finance/>
- Zeng, H., Abedin, M., Lucey, B., & Ma, S. (2025). Tail risk contagion and multiscale spillovers in the green finance index and large US technology stocks. *International Review of Financial Analysis*, 97, 1-23. Internet access: <https://doi.org/10.1016/j.irfa.2024.103865>

Zhang X., K. L. (2024). Shades of green: The impact of greenwashing on stock price. *Finance Research Letters*, 70, 1-10.

Zheng, X., Kong, L., & Hu, X. (2024). Global characteristics and trends of researches on watermelon: Based on bibliometric and visualized analysis. *Heliyon*, 10, 1-12. Internet access: <https://doi.org/10.1016/j.frl.2024.106285>

**ŽALIASIS FINANSAVIMAS IR DARNUS VYSTYMASIS BALTIJOS JŪROS REGIONO
ŠALYSE**

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Magistro darbas

Finansų ir bankininkystės programa

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Darbo vadovas – prof. dr. Jelena Stankevičienė, Vilnius, 2026

SUMMARY IN LITHUANIAN

82 puslapiai, 20 lentelių, 2 paveikslai, 70 šaltinių.

Šio magistro darbo tikslas yra išanalizuoti žaliuosius finansus ir darnų vystymąsi bei remiantis sudaryta metodologija, ištirti jų vystymąsi Baltijos jūros regiono šalyse.

Darbas susideda iš trijų pagrindinių dalių. Pirmoje dalyje pateikiama literatūros analizė apie žaliuosius finansus, analizuojama žaliųjų finansų sąvoka, žalieji finansiniai instrumentai, privalumai ir trūkumai ir pagrindiniai žaliųjų finansų sistemos dalyviai. Darnus vystymasis yra išanalizuotas remiantis moksliniais straipsniais atrinktais Web of Science platformoje ir pasitelkiant VOSviewer programą straipsniai yra sugrupuoti į 7 pagrindines dalis, remiantis raktiniais žodžiais. Taip pat, pateikiama informacija apie žaliuosius finansus ir darnų vystymąsi Baltijos jūros regiono šalyse.

Antrojoje darbo dalyje pateikiama tyrimo schema, kuria remiantis bus išanalizuotos keturios išsikeltos hipotezės. Tai bus atilikta remiantis penelinės regresijos, fiksuotų efektų ir atsitiktinių efektų regresijos modeliais. Taip pat, bus atlikti dispersijos didinimo koeficiento, Breusch-Pagan Langrage ir Hausman testai, kad būtų ištirta, kuris regresijos modelis yra tinkamiausias išsikeltooms hipotezėms.

Trečiojoje darbo dalyje pateikiami tyrimo rezultatai, kuriuos analizuojant buvo ištirta, kad žalieji finansai turi įtakos tvarumui Baltijos jūros regione, ypač tvarumo indeksui ir atsinaujinančios energetikos suvartojimui. Tačiau, žaliųjų finansinių instrumentų įtaka HDI indeksui ir institucinei kokybei yra ribota, šias sritis stipriau lemia ekonominiai ir socialiniai veiksniai, pavyzdžiui, BVP, išlaidos švietimui bei sveikatos apsaugai ar demokratinės raidos lygis. Apibendrinant galima teigti, kad žaliasis finansavimas skatina aplinkosauginius ir plėtros pokyčius, tačiau platesni jo poveikiai visuomenei ir institucijoms greičiausiai pasireiškia palaiptiesiems ir priklauso nuo papildomų struktūrinių sąlygų.

**GREEN FINANCE AND SUSTAINABLE DEVELOPMENT IN BALTIC SEA REGION
COUNTRIES**

Rosita BUBELYTĖ

Master Thesis

Finance and Banking Programme

Faculty of Economics and Business Administration, Vilnius University

Supervisor prof. dr. Jelena Stankevičienė, Vilnius, 2026

SUMMARY IN ENGLISH

82 pages, 20 tables, 2 figures, 70 references.

The purpose of this master's thesis is to analyze green finance and sustainable development, and, based on the methodology, examine their development in Baltic Sea Region countries. The thesis consists of three main parts. In the first part, a literature review of green finance and sustainable development is presented. When analyzing green finance, definitions, green finance instruments, benefits and drawbacks, and key actors in the green financial system are discussed. The topic of sustainable development is analyzed using the VOSviewer program, which systematized 10,000 articles from Web of Science and divided them into seven main topics based on keywords. Furthermore, the main findings related to this topic in the Baltic Sea Region countries are presented. The second part describes the development of hypotheses and outlines the methodologies used to address the key research questions. The research scheme presents that panel regression, fixed-effect regression and random-effect regression models will be used to test the hypotheses. After that, Variance Inflation Factor, Breusch-Pagan Lagrange Multiplier Test and Hausman Test will be performed to analyze and support results.

The third part presents an empirical study along with the main results. Across the four hypotheses, the results show that green finance plays a meaningful role in supporting sustainable development outcomes in the Baltic Sea Region, particularly through its positive association with the Sustainable Development Index and renewable energy consumption. However, its direct influence on human development and institutional quality appears limited, with economic and social factors such as GDP growth, education, healthcare expenditure, and democratic governance serving as stronger predictors in these areas. To conclude, the findings suggest that while green finance contributes to environmental and developmental progress, its broader societal and institutional effects likely emerge gradually and depend on complementary structural conditions.

ANNEXES

Annex 1. Sustainable Development Index, green finance and sustainable-linked bonds issuance, GDP per capita, foreign direct investment, net and population in Lithuania, Latvia, Estonia, Finland, Sweden, Denmark, Germany and Poland in 2014-2024

Country	Year	SDI	GF (in \$ billions)	GDP per capita, PPP (current international \$)	Foreign direct investment, net (BoP, current US\$)	Population
Lithuania	2014	76.3	-	28,005.79	188,404,473.21	2,937,253
Lithuania	2015	77.1	-	28,854.00	(680,317,054.69)	2,911,109
Lithuania	2016	77.1	-	30,772.67	(264,618,974.69)	2,877,325
Lithuania	2017	77.3	0.31	33,591.56	(932,827,114.81)	2,842,639
Lithuania	2018	76.7	0.46	36,491.94	(260,129,818.34)	2,819,200
Lithuania	2019	76.9	-	40,563.83	(1,272,922,205.62)	2,811,089
Lithuania	2020	77.9	-	41,262.73	(631,424,592.01)	2,810,369
Lithuania	2021	77.7	0.04	45,873.53	(1,237,540,186.50)	2,808,380
Lithuania	2022	78.4	0.08	50,498.38	(3,222,401,216.98)	2,831,639
Lithuania	2023	78.9	-	50,914.86	(1,424,642,070.46)	2,871,585
Lithuania	2024	78.8	-	54,413.96	(3,439,469,848.40)	2,888,055
Latvia	2014	78.6	-	22,973.69	(349,596,498.13)	1,993,782
Latvia	2015	79.1	0.10	24,137.88	(669,889,910.96)	1,977,527
Latvia	2016	79.4	0.03	25,802.16	(90,059,355.45)	1,959,537
Latvia	2017	79.9	0.02	27,645.82	(614,005,630.49)	1,942,248
Latvia	2018	79.7	-	29,817.80	(750,923,583.21)	1,927,174
Latvia	2019	80.6	-	32,199.10	(1,027,750,185.52)	1,913,822
Latvia	2020	80.6	-	32,741.42	(741,593,243.06)	1,900,449
Latvia	2021	80.7	1.41	36,912.01	(1,057,545,380.95)	1,884,490
Latvia	2022	81.2	0.10	39,960.84	(1,385,206,180.72)	1,879,383
Latvia	2023	81.4	0.05	41,810.01	(670,181,723.33)	1,877,445
Latvia	2024	81.2	-	43,866.96	(1,062,847,221.75)	1,862,441
Estonia	2014	77.7	-	29,403.66	(644,935,503.45)	1,314,545
Estonia	2015	79.0	0.07	29,720.59	140,346,638.37	1,315,407
Estonia	2016	78.7	-	31,947.78	(560,003,486.30)	1,315,790
Estonia	2017	79.3	-	34,506.65	(1,085,198,792.99)	1,317,384
Estonia	2018	79.4	-	37,120.99	(1,488,485,687.13)	1,321,977
Estonia	2019	80.3	-	40,586.38	(1,219,292,689.66)	1,326,898
Estonia	2020	80.9	-	40,672.13	(3,434,672,493.27)	1,329,522
Estonia	2021	80.3	-	44,251.54	(1,211,996,049.69)	1,330,932
Estonia	2022	80.8	-	47,802.01	(164,683,262.65)	1,348,840
Estonia	2023	80.8	-	46,790.27	(3,145,151,486.46)	1,370,286
Estonia	2024	80.8	4.60	49,333.81	(210,021,997.23)	1,371,986
Finland	2014	86.0	0.55	41,547.10	(17,670,889,528.46)	5,461,512
Finland	2015	86.3	0.83	42,269.22	(18,023,726,570.09)	5,479,531

Finland	2016	86.2	3.02	44,562.40	15,196,877,456.52	5,495,303
Finland	2017	86.1	2.24	47,234.85	(3,098,225,281.17)	5,508,214
Finland	2018	85.9	0.66	49,248.68	13,824,242,516.64	5,515,525
Finland	2019	86.4	3.61	52,276.11	(9,562,706,116.04)	5,521,606
Finland	2020	86.9	6.83	53,296.58	8,127,754,117.33	5,529,543
Finland	2021	86.8	6.30	56,790.38	(3,470,347,077.78)	5,541,017
Finland	2022	87.0	7.79	61,347.16	8,978,038,357.68	5,556,106
Finland	2023	87.1	9.98	61,612.94	(730,351,924.53)	5,583,911
Finland	2024	87.0	8.91	64,091.23	3,584,762,780.18	5,637,214
Sweden	2014	85.6	1.44	46,841.40	4,379,038,741.84	9,696,110
Sweden	2015	85.6	1.49	48,785.16	4,491,589,833.52	9,799,186
Sweden	2016	85.7	3.52	50,289.77	(15,487,787,967.71)	9,923,085
Sweden	2017	85.7	4.30	51,474.12	14,313,051,278.23	10,057,698
Sweden	2018	85.2	6.68	53,122.44	14,173,793,379.39	10,175,214
Sweden	2019	85.8	12.98	57,046.45	6,038,490,207.49	10,278,887
Sweden	2020	86.1	17.84	57,489.27	4,071,711,652.47	10,353,442
Sweden	2021	85.6	20.24	62,731.70	5,351,116,533.03	10,415,811
Sweden	2022	85.9	18.51	66,375.62	11,838,691,579.22	10,486,941
Sweden	2023	86.1	21.62	67,258.85	22,420,829,143.36	10,536,632
Sweden	2024	85.7	23.79	71,030.46	8,957,021,405.58	10,569,709
Denmark	2014	83.9	-	47,879.60	3,342,265,730.45	5,643,475
Denmark	2015	84.6	0.59	48,910.33	5,642,339,768.00	5,683,483
Denmark	2016	84.6	-	51,820.95	10,094,434,246.73	5,728,010
Denmark	2017	84.5	1.83	55,271.60	6,536,057,842.61	5,764,980
Denmark	2018	84.1	0.78	57,233.62	(2,434,129,011.64)	5,793,636
Denmark	2019	84.7	11.39	60,594.97	9,775,759,922.64	5,814,422
Denmark	2020	85.0	1.65	62,682.29	8,270,778,011.43	5,831,404
Denmark	2021	84.9	10.23	69,715.18	19,477,235,885.79	5,856,733
Denmark	2022	85.0	21.18	77,400.33	1,557,800,460.94	5,903,037
Denmark	2023	85.3	17.71	73,737.45	6,247,097,182.73	5,946,952
Denmark	2024	85.3	9.79	79,514.29	13,097,627,142.48	5,976,992
Germany	2014	81.9	3.94	47,938.80	88,131,616,218.35	80,982,500
Germany	2015	82.5	7.39	48,558.44	56,842,205,697.63	81,686,611
Germany	2016	82.7	5.95	51,569.90	58,421,887,790.00	82,348,669
Germany	2017	82.9	10.40	54,110.25	40,199,657,620.22	82,657,002
Germany	2018	82.7	9.03	56,273.04	50,675,924,607.22	82,905,782
Germany	2019	83.0	29.63	59,270.73	95,880,604,151.08	83,092,962
Germany	2020	83.4	70.39	58,685.87	(31,910,918,320.74)	83,160,871
Germany	2021	83.2	111.43	62,530.77	87,095,736,501.59	83,196,078
Germany	2022	83.5	102.96	67,589.84	63,702,049,813.46	83,797,985
Germany	2023	83.6	98.17	68,692.89	25,873,960,000.69	83,901,923
Germany	2024	83.7	77.88	72,300.12	32,564,762,200.25	83,510,950
Poland	2014	79.2	-	25,459.74	(14,109,000,000.00)	38,011,735

Poland	2015	79.6	-	26,995.34	(10,753,000,000.00)	37,986,412
Poland	2016	80.3	1.57	28,359.69	(4,059,000,000.00)	37,970,087
Poland	2017	80.5	-	30,170.28	(8,631,000,000.00)	37,974,826
Poland	2018	80.3	2.09	32,345.11	(17,470,000,000.00)	37,974,750
Poland	2019	80.8	4.40	35,882.37	(13,643,000,000.00)	37,965,475
Poland	2020	81.1	0.50	37,089.30	(15,013,000,000.00)	37,515,748
Poland	2021	81.1	2.59	41,059.58	(27,292,000,000.00)	36,981,559
Poland	2022	81.8	0.52	46,077.39	(29,177,000,000.00)	36,821,749
Poland	2023	82.0	2.84	46,757.54	(19,539,000,000.00)	36,687,353
Poland	2024	82.1	2.54	50,378.06	(10,692,000,000.00)	36,554,707

Annex 2: Renewable energy as a % of gross final energy consumption, green finance and sustainable-linked bonds issuance, GDP per capita, energy prices in euros, population in Lithuania, Latvia, Estonia, Finland, Sweden, Denmark, Germany and Poland in 2014-2024

Country	Year	RE	GF (in \$ billions)	GDP per capita, PPP (current international \$)	EP	Population
Lithuania	2014	23.59	-	28,005.79	0.1325	2,937,253
Lithuania	2015	25.75	-	28,854.00	0.1250	2,911,109
Lithuania	2016	25.61	-	30,772.67	0.1201	2,877,325
Lithuania	2017	26.04	0.31	33,591.56	0.1112	2,842,639
Lithuania	2018	24.70	0.46	36,491.94	0.1097	2,819,200
Lithuania	2019	25.47	-	40,563.83	0.1255	2,811,089
Lithuania	2020	26.77	-	41,262.73	0.1374	2,810,369
Lithuania	2021	28.17	0.04	45,873.53	0.1413	2,808,380
Lithuania	2022	29.60	0.08	50,498.38	0.1963	2,831,639
Lithuania	2023	31.93	-	50,914.86	0.2522	2,871,585
Lithuania	2024	35.41	-	54,413.96	0.2230	2,888,055
Latvia	2014	38.63	-	22,973.69	0.1333	1,993,782
Latvia	2015	37.54	0.10	24,137.88	0.1643	1,977,527
Latvia	2016	37.14	0.03	25,802.16	0.1626	1,959,537
Latvia	2017	39.01	0.02	27,645.82	0.1584	1,942,248
Latvia	2018	40.02	-	29,817.80	0.1521	1,927,174
Latvia	2019	4.93	-	32,199.10	0.1635	1,913,822
Latvia	2020	42.13	-	32,741.42	0.1426	1,900,449
Latvia	2021	42.10	1.41	36,912.01	0.1645	1,884,490
Latvia	2022	43.72	0.10	39,960.84	0.2376	1,879,383
Latvia	2023	43.22	0.05	41,810.01	0.2914	1,877,445
Latvia	2024	45.54	-	43,866.96	0.2413	1,862,441
Estonia	2014	26.13	-	29,403.66	0.1316	1,314,545
Estonia	2015	28.99	0.07	29,720.59	0.1297	1,315,407
Estonia	2016	29.23	-	31,947.78	0.1223	1,315,790
Estonia	2017	29.54	-	34,506.65	0.1263	1,317,384
Estonia	2018	29.97	-	37,120.99	0.1383	1,321,977
Estonia	2019	31.73	-	40,586.38	0.1384	1,326,898
Estonia	2020	30.07	-	40,672.13	0.1264	1,329,522
Estonia	2021	37.34	-	44,251.54	0.1632	1,330,932
Estonia	2022	38.54	-	47,802.01	0.2353	1,348,840
Estonia	2023	40.95	-	46,790.27	0.2250	1,370,286
Estonia	2024	38.020	4.60	49,333.81	0.2257	1,371,986
Finland	2014	38.63	0.55	41,547.10	0.1551	5,461,512
Finland	2015	39.23	0.83	42,269.22	0.1541	5,479,531
Finland	2016	38.94	3.02	44,562.40	0.1543	5,495,303

Finland	2017	40.86	2.24	47,234.85	0.1590	5,508,214
Finland	2018	41.19	0.66	49,248.68	0.1655	5,515,525
Finland	2019	42.81	3.61	52,276.11	0.1759	5,521,606
Finland	2020	43.94	6.83	53,296.58	0.1757	5,529,543
Finland	2021	42.85	6.30	56,790.38	0.1804	5,541,017
Finland	2022	47.74	7.79	61,347.16	0.2204	5,556,106
Finland	2023	50.75	9.98	61,612.94	0.2480	5,583,911
Finland	2024	52.10	8/91	64,091.23	0.2824	5,637,214
Sweden	2014	51.15	1.44	46,841.40	0.1917	9,696,110
Sweden	2015	52.22	1.49	48,785.16	0.1873	9,799,186
Sweden	2016	52.60	3.52	50,289.77	0.1939	9,923,085
Sweden	2017	53.39	4.30	51,474.12	0.1984	10,057,698
Sweden	2018	53.92	6.68	53,122.44	0.1980	10,175,214
Sweden	2019	55.79	12.98	57,046.45	0.2043	10,278,887
Sweden	2020	60.12	17.84	57,489.27	0.1966	10,353,442
Sweden	2021	62.53	20.24	62,731.70	0.2359	10,415,811
Sweden	2022	66.29	18.51	66,375.62	0.2509	10,486,941
Sweden	2023	66.39	21.62	67,258.85	0.2422	10,536,632
Sweden	2024	62.85	23.79	71,030.46	0.2393	10,569,709
Denmark	2014	29.31	-	47,879.60	0.3039	5,643,475
Denmark	2015	30.47	0.59	48,910.33	0.3055	5,683,483
Denmark	2016	31.72	-	51,820.95	0.3086	5,728,010
Denmark	2017	34.39	1.83	55,271.60	0.3030	5,764,980
Denmark	2018	35.16	0.78	57,233.62	0.3125	5,793,636
Denmark	2019	37.02	11.39	60,594.97	0.2954	5,814,422
Denmark	2020	31.68	1.65	62,682.29	0.2826	5,831,404
Denmark	2021	41.81	10.23	69,715.18	0.3174	5,856,733
Denmark	2022	42.38	21.18	77,400.33	0.5215	5,903,037
Denmark	2023	44.92	17.71	73,737.45	0.3683	5,946,952
Denmark	2024	46.76	9.79	79,514.29	0.3736	5,976,992
Germany	2014	14.38	3.94	47,938.80	0.2978	80,982,500
Germany	2015	14.90	7.39	48,558.44	0.2949	81,686,611
Germany	2016	14.89	5.95	51,569.90	0.2973	82,348,669
Germany	2017	15.47	10.40	54,110.25	0.3048	82,657,002
Germany	2018	16.66	9.03	56,273.04	0.2994	82,905,782
Germany	2019	17.27	29.63	59,270.73	0.2983	83,092,962
Germany	2020	19.09	70.39	58,685.87	0.3025	83,160,871
Germany	2021	19.28	111.43	62,530.77	0.3214	83,196,078
Germany	2022	20.91	102.96	67,589.84	0.3318	83,797,985
Germany	2023	21.55	98.17	68,692.89	0.4073	83,901,923
Germany	2024	22.47	77.88	72,300.12	0.3947	83,510,950
Poland	2014	11.61	-	25,459.74	0.1415	38,011,735
Poland	2015	11.88	-	26,995.34	0.1431	37,986,412

Poland	2016	11.40	1.57	28,359.69	0.1342	37,970,087
Poland	2017	11.06	-	30,170.28	0.1449	37,974,826
Poland	2018	14.94	2.09	32,345.11	0.1403	37,974,750
Poland	2019	15.38	4.40	35,882.37	0.1360	37,965,475
Poland	2020	16.10	0.50	37,089.30	0.1493	37,515,748
Poland	2021	15.62	2.59	41,059.58	0.1561	36,981,559
Poland	2022	16.85	0.52	46,077.39	0.1534	36,821,749
Poland	2023	16.50	2.84	46,757.54	0.1966	36,687,353
Poland	2024	17.77	2.54	50,378.06	0.2284	36,554,707

Annex 3. Human Development Index, green finance and sustainable-linked bonds issuance, GDP per capita, educational expenditures as a % of GDP, healthcare expenditures as a % of GDP in Lithuania, Latvia, Estonia, Finland, Sweden, Denmark, Germany and Poland in 2013-2023

Country	Year	HDI	GF (in \$ billions)	GDP per capita, PPP (current international \$)	EdEx	HEx
Lithuania	2013	0.87	-	26,563.37	4.62	6.16
Lithuania	2014	0.87	-	28,005.79	4.51	6.22
Lithuania	2015	0.87	-	28,854.00	4.22	6.47
Lithuania	2016	0.88	-	30,772.67	4.01	6.65
Lithuania	2017	0.89	0.31	33,591.56	3.81	6.46
Lithuania	2018	0.89	0.46	36,491.94	3.86	6.47
Lithuania	2019	0.89	-	40,563.83	3.94	6.94
Lithuania	2020	0.89	-	41,262.73	4.47	7.42
Lithuania	2021	0.89	0.04	45,873.53	4.24	7.73
Lithuania	2022	0.89	0.08	50,498.38	4.25	7.24
Lithuania	2023	0.90	-	50,914.86	5.15	7.32
Latvia	2013	0.85	-	21,850.13	7.25	5.60
Latvia	2014	0.85	-	22,973.69	5.47	5.66
Latvia	2015	0.86	0.10	24,137.88	5.47	5.85
Latvia	2016	0.86	0.03	25,802.16	4.82	6.35
Latvia	2017	0.87	0.02	27,645.82	4.53	6.19
Latvia	2018	0.88	-	29,817.80	4.39	6.41
Latvia	2019	0.88	-	32,199.10	4.59	6.86
Latvia	2020	0.88	-	32,741.42	5.00	7.51
Latvia	2021	0.87	1.41	36,912.01	4.77	9.41
Latvia	2022	0.88	0.10	39,960.84	4.32	8.10
Latvia	2023	0.89	0.05	41,810.01	6.09	7.28
Estonia	2013	0.89	-	27,831.15	4.78	6.20
Estonia	2014	0.89	-	29,403.66	4.33	6.26
Estonia	2015	0.89	0.07	29,720.59	5.05	6.52
Estonia	2016	0.89	-	31,947.78	5.06	6.57
Estonia	2017	0.89	-	34,506.65	4.86	6.47
Estonia	2018	0.90	-	37,120.99	5.14	6.56
Estonia	2019	0.90	-	40,586.38	5.16	6.65
Estonia	2020	0.90	-	40,672.13	5.44	7.47
Estonia	2021	0.90	-	44,251.54	5.22	7.48
Estonia	2022	0.90	-	47,802.01	5.21	6.94
Estonia	2023	0.91	-	46,790.27	6.28	7.47
Finland	2013	0.93	0.23	41,325.81	7.15	9.85
Finland	2014	0.94	0.55	41,547.10	7.14	9.83
Finland	2015	0.94	0.83	42,269.22	7.07	9.70

Finland	2016	0.94	3.02	44,562.40	6.91	9.46
Finland	2017	0.94	2.24	47,234.85	6.41	9.19
Finland	2018	0.95	0.66	49,248.68	6.32	9.10
Finland	2019	0.95	3.61	52,276.11	6.45	9.22
Finland	2020	0.95	6.83	53,296.58	6.68	9.70
Finland	2021	0.95	6.30	56,790.38	6.59	9.91
Finland	2022	0.95	7.79	61,347.16	6.38	9.74
Finland	2023	0.95	9.98	61,612.94	6.34	10.47
Sweden	2013	0.94	0.17	46,098.23	7.65	10.99
Sweden	2014	0.94	1.44	46,841.40	7.63	11.07
Sweden	2015	0.95	1.49	48,785.16	7.49	10.93
Sweden	2016	0.95	3.52	50,289.77	7.64	10.96
Sweden	2017	0.95	4.30	51,474.12	7.64	10.95
Sweden	2018	0.95	6.68	53,122.44	7.70	11.09
Sweden	2019	0.96	12.98	57,046.45	7.66	10.93
Sweden	2020	0.95	17.84	57,489.27	7.95	11.42
Sweden	2021	0.96	20.24	62,731.70	7.60	11.23
Sweden	2022	0.96	18.51	66,375.62	7.32	10.86
Sweden	2023	0.96	21.62	67,258.85	7.18	11.15
Denmark	2013	0.94	-	46,869.19	8.47	10.30
Denmark	2014	0.94	-	47,879.60	7.64	10.31
Denmark	2015	0.94	0.59	48,910.33	7.01	10.38
Denmark	2016	0.95	-	51,820.95	7.72	10.28
Denmark	2017	0.95	1.83	55,271.60	7.37	10.11
Denmark	2018	0.95	0.78	57,233.62	7.33	10.14
Denmark	2019	0.95	11.39	60,594.97	7.28	10.18
Denmark	2020	0.95	1.65	62,682.29	7.39	10.69
Denmark	2021	0.96	10.23	69,715.18	6.96	10.66
Denmark	2022	0.96	21.18	77,400.33	6.36	9.47
Denmark	2023	0.96	17.71	73,737.45	5.53	9.51
Germany	2013	0.95	0.31	45,889.02	4.84	10.74
Germany	2014	0.95	3.94	47,938.80	4.83	10.77
Germany	2015	0.95	7.39	48,558.44	4.76	10.92
Germany	2016	0.95	5.95	51,569.90	4.75	10.97
Germany	2017	0.95	10.40	54,110.25	4.78	11.05
Germany	2018	0.95	9.03	56,273.04	4.88	11.18
Germany	2019	0.96	29.63	59,270.73	5.03	11.43
Germany	2020	0.96	70.39	58,685.87	5.52	12.47
Germany	2021	0.96	111.43	62,530.77	5.37	12.72
Germany	2022	0.96	102.96	67,589.84	5.24	12.45
Germany	2023	0.96	98.17	68,692.89	4.47	11.74
Poland	2013	0.87	-	24,433.89	5.00	6.45
Poland	2014	0.87	-	25,459.74	4.94	6.28

Poland	2015	0.88	-	26,995.34	4.79	6.31
Poland	2016	0.88	1.57	28,359.69	4.63	6.49
Poland	2017	0.88	-	30,170.28	4.54	6.54
Poland	2018	0.88	2.09	32,345.11	4.56	6.25
Poland	2019	0.89	4.40	35,882.37	4.63	6.39
Poland	2020	0.88	0.50	37,089.30	4.80	6.43
Poland	2021	0.88	2.59	41,059.58	4.62	6.37
Poland	2022	0.90	0.52	46,077.39	4.31	6.47
Poland	2023	0.91	2.84	46,757.54	4.96	7.14

Annex 4: Institutional quality index, green finance and sustainable-linked bonds issuance, GDP per capita, foreign direct investment, net, democracy index in Lithuania, Latvia, Estonia, Finland, Sweden, Denmark, Germany and Poland in 2012-2022

Country	Year	IQI	GF (in \$ billions)	GDP per capita, PPP (current international \$)	Foreign direct investment, net (BoP, current US\$)	DI
Lithuania	2012	74.78	-	24,566.90	(255,287,867.83)	7.24
Lithuania	2013	76.07	-	26,563.37	(436,800,371.87)	7.54
Lithuania	2014	76.72	-	28,005.79	188,404,473.21	7.54
Lithuania	2015	78.22	-	28,854.00	(680,317,054.69)	7.54
Lithuania	2016	78.47	-	30,772.67	(264,618,974.69)	7.47
Lithuania	2017	76.70	0.31	33,591.56	(932,827,114.81)	7.41
Lithuania	2018	75.78	0.46	36,491.94	(260,129,818.34)	7.50
Lithuania	2019	78.27	-	40,563.83	(1,272,922,205.62)	7.50
Lithuania	2020	80.63	-	41,262.73	(631,424,592.01)	77.13
Lithuania	2021	80.65	0.04	45,873.53	(1,237,540,186.50)	7.18
Lithuania	2022	79.55	0.08	50,498.38	(3,222,401,216.98)	7.31
Latvia	2012	70.62	-	20,494.05	(919,475,458.85)	7.05
Latvia	2013	71.97	-	21,850.13	(494,130,035.32)	7.05
Latvia	2014	73.67	-	22,973.69	(349,596,498.13)	7.48
Latvia	2015	72.95	0.10	24,137.88	(669,889,910.96)	7.37
Latvia	2016	73.43	0.03	25,802.16	(90,059,355.45)	7.31
Latvia	2017	73.68	0.02	27,645.82	(614,005,630.49)	7.25
Latvia	2018	72.83	-	29,817.80	(750,923,583.21)	7.39
Latvia	2019	74.45	-	32,199.10	(1,027,750,185.52)	7.49
Latvia	2020	74.83	-	32,741.42	(741,593,243.06)	7.24
Latvia	2021	77.13	1.41	36,912.01	(1,057,545,380.95)	7.31
Latvia	2022	75.37	0.10	39,960.84	(1,385,206,180.72)	7.37
Estonia	2012	81.48	-	26,242.53	(505,876,815.37)	7.61
Estonia	2013	82.02	-	27,831.15	(246,699,019.41)	7.61
Estonia	2014	84.95	-	29,403.66	(644,935,503.45)	7.74
Estonia	2015	83.88	0.07	29,720.59	140,346,638.37	7.85
Estonia	2016	84.38	-	31,947.78	(560,003,486.30)	7.85
Estonia	2017	84.48	-	34,506.65	(1,085,198,792.99)	7.79
Estonia	2018	84.13	-	37,120.99	(1,488,485,687.13)	7.97
Estonia	2019	84.97	-	40,586.38	(1,219,292,689.66)	7.90
Estonia	2020	86.62	-	40,672.13	(3,434,672,493.27)	7.84
Estonia	2021	86.55	-	44,251.54	(1,211,996,049.69)	7.84
Estonia	2022	87.03	-	47,802.01	(164,683,262.65)	7.96
Finland	2012	98.42	0.05	40,739.11	3,443,682,040.61	9.06
Finland	2013	98.43	0.23	41,325.81	(2,335,162,154.22)	9.03
Finland	2014	98.32	0.55	41,547.10	(17,670,889,528.46)	9.03

Finland	2015	96.33	0.83	42,269.22	(18,023,726,570.09)	9.03
Finland	2016	96.00	3.02	44,562.40	15,196,877,456.52	9.03
Finland	2017	96.58	2.24	47,234.85	(3,098,225,281.17)	9.03
Finland	2018	95.33	0.66	49,248.68	13,824,242,516.64	9.14
Finland	2019	95.18	3.61	52,276.11	(9,562,706,116.04)	9.25
Finland	2020	96.22	6.83	53,296.58	8,127,754,117.33	9.20
Finland	2021	96.60	6.30	56,790.38	(3,470,347,077.78)	9.27
Finland	2022	95.13	7.79	61,347.16	8,978,038,357.68	9.29
Sweden	2012	97.57	-	45,206.99	13,221,654,816.08	9.73
Sweden	2013	97.18	0.17	46,098.23	26,562,451,326.62	9.73
Sweden	2014	95.60	1.44	46,841.40	4,379,038,741.84	9.73
Sweden	2015	94.42	1.49	48,785.16	4,491,589,833.52	9.45
Sweden	2016	95.85	3.52	50,289.77	(15,487,787,967.71)	9.39
Sweden	2017	94.37	4.30	51,474.12	14,313,051,278.23	9.39
Sweden	2018	94.07	6.68	53,122.44	14,173,793,379.39	9.39
Sweden	2019	94.63	12.98	57,046.45	6,038,490,207.49	9.39
Sweden	2020	93.92	17.84	57,489.27	4,071,711,652.47	9.26
Sweden	2021	94.37	20.24	62,731.70	5,351,116,533.03	9.26
Sweden	2022	93.05	18.51	66,375.62	11,838,691,579.22	9.39
Denmark	2012	94.95	-	44,755.16	5,411,285,380.97	9.52
Denmark	2013	95.82	-	46,869.19	6,328,175,744.81	9.38
Denmark	2014	94.18	-	47,879.60	3,342,265,730.45	9.11
Denmark	2015	93.97	0.59	48,910.33	5,642,339,768.00	9.11
Denmark	2016	93.63	-	51,820.95	10,094,434,246.73	9.20
Denmark	2017	92.82	1.83	55,271.60	6,536,057,842.61	9.22
Denmark	2018	94.08	0.78	57,233.62	(2,434,129,011.64)	9.22
Denmark	2019	94.55	11.39	60,594.97	9,775,759,922.64	9.22
Denmark	2020	94.87	1.65	62,682.29	8,270,778,011.43	9.15
Denmark	2021	95.67	10.23	69,715.18	19,477,235,885.79	9.09
Denmark	2022	95.28	21.18	77,400.33	1,557,800,460.94	9.28
Germany	2012	89.10	-	44,229.39	33,639,173,474.09	8.34
Germany	2013	89.82	0.31	45,889.02	26,093,621,454.52	8.31
Germany	2014	91.63	3.94	47,938.80	88,131,616,218.35	8.64
Germany	2015	89.58	7.39	48,558.44	56,842,205,697.63	8.64
Germany	2016	89.90	5.95	51,569.90	58,421,887,790.00	8.63
Germany	2017	89.25	10.40	54,110.25	40,199,657,620.22	8.61
Germany	2018	88.90	9.03	56,273.04	50,675,924,607.22	8.68
Germany	2019	89.33	29.63	59,270.73	95,880,604,151.08	8.68
Germany	2020	88.28	70.39	58,685.87	(31,910,918,320.74)	8.67
Germany	2021	89.08	111.43	62,530.77	87,095,736,501.59	8.67
Germany	2022	88.37	102.96	67,589.84	63,702,049,813.46	8.80
Poland	2012	77.47	-	23,728.15	(5,997,000,000.00)	7.12
Poland	2013	76.53	-	24,433.89	(4,440,000,000.00)	7.12

Poland	2014	77.55	-	25,459.74	(14,109,000,000.00)	7.47
Poland	2015	76.90	-	26,995.34	(10,753,000,000.00)	7.09
Poland	2016	72.78	1.57	28,359.69	(4,059,000,000.00)	6.83
Poland	2017	70.48	-	30,170.28	(8,631,000,000.00)	6.67
Poland	2018	70.28	2.09	32,345.11	(17,470,000,000.00)	6.67
Poland	2019	70.15	4.40	35,882.37	(13,643,000,000.00)	6.62
Poland	2020	68.17	0.50	37,089.30	(15,013,000,000.00)	6.85
Poland	2021	65.77	2.59	41,059.58	(27,292,000,000.00)	6.80
Poland	2022	66.07	0.52	46,077.39	(29,177,000,000.00)	7.04