economies

MDPI

Article

Analysis of Success Factors, Benefits, and Challenges of Issuing Green Bonds in Lithuania

Julija Bužinskė [1,*] and Jelena Stankevičienė [2,*]

[1] Department of Financial Engineering, Business Management Faculty, Vilnius Gediminas Technical University (VILNIUS TECH), LT-10223 Vilnius, Lithuania
[2] Department of Finance, Faculty Economics and Business Administration, Vilnius University, LT-01513 Vilnius, Lithuania
* Correspondence: julija.buzinske@vilniustech.lt (J.B.); jelena.stankeviciene@evaf.vu.lt (J.S.)

Abstract: The objective of this study is to establish understanding of the success factors in issuing green bonds including the corresponding benefits and challenges of their issuance in Lithuania. The research methodology is comprised of the three parts: (1) a literature review to examine the success factors, benefits, and challenges of issuing green bonds as identified by researchers in different countries; (2) use of the methodological potential of the analysed field to formulate an expert survey via the analytical hierarchy process method; (3) summary of the results of the survey and proposals for its further development. Findings suggest that the reputation, good credit rating, and the environmental, social, and governance score of the issuer are the key considerations in the success of green bonds issuance. On the benefits side, green bonds bear low investment risks with the ability to raise large investment amounts while providing quantifiable and measurable benefits. The challenges related to the issuance of green bonds include greenwashing, the questionable role of the green bond market in environmental protection, and insufficient financial and economic benefits of issuance. Practical implications of the study are based on the notion that findings can be applied as a reference point by potential issuers willing to issue green bonds, investors willing to invest in green bonds, and policy-makers willing to promote sustainable and green finance. An original aspect of this paper is its study focus on peculiarities of the issuance of green bonds in the region, in a smaller country which can serve as a reference point for considering potential issuance of green bonds.

Keywords: green finance; green bonds; analytical hierarchy process; green bond issuance

Citation: Bužinskė, Julija, and Jelena Stankevičienė. 2023. Analysis of Success Factors, Benefits, and Challenges of Issuing Green Bonds in Lithuania. *Economies* 11: 143. https://doi.org/10.3390/economies11050143

Academic Editor: Ştefan Cristian Gherghina

Received: 26 March 2023
Revised: 5 May 2023
Accepted: 8 May 2023
Published: 10 May 2023

1. Introduction

Green bonds are the instruments of the green finance market (Chopra and Mehta 2023; Wang et al. 2023), aimed at financing green projects around the globe (García et al. 2023; Tomfort 2022; Ye and Rasoulinezhad 2023; Zenno and Aruga 2023). The growth of the green bond market resulted from the ratification of the Paris Agreement adopted in 2015 and subsequent political decisions to promote international investments in green bonds. In addition, the introduction of green bonds was a part of the innovative economic policy that evolved after the 2008 financial crisis. After the crisis, institutional investors shifted to more sustainable financial market products that can preserve the value of investments while guaranteeing revenue and reducing risks (Banga 2019). Therefore, development of the green bond market is closely related to the rise of green finance, where the stock market plays an important role in environmental preservation (Siracusa 2021; Zeqiraj et al. 2020). Various drivers have been identified corresponding to the development of green finance products (Sachs et al. 2019).

Academics (Sachs et al. 2019) have identified the drivers corresponding to the development of green finance products. Firstly, the environmental education of the public through the mass media means plays an important role in the advancement of green finance. Here, the knowledge gained through mass media channels helps to build understanding of the

global environmental situation and challenges. Secondly, the increased attention paid by governments to environmental challenges may help to stimulate public awareness of environmental matters, and, in turn, correspond to the promotion of green finance products. Furthermore, policy-makers can contribute to the development of green finance products by taking sustainable decisions on environmental protection, regulations, and legislations to prevent harmful actions towards environment.

The green bond market has grown significantly over the years (Zhang et al. 2022); however, it is still a niche market (Migliorelli and Dessertine 2019; Nguyen et al. 2023). The rationale for the growth of the green bond market can be explained in the following way (Banga 2019). Firstly, policy makers, governments, investors, and other stakeholders have now recognised the effects of environmental risks imposed on financial and private companies and on the economy overall. The understanding of climate preservation challenges has stipulated legislative and preventive measures to create a climate-resilient economy. Investors also have reacted to environmental concerns and include environmental, social, and governance (ESG) criteria in their decision-making processes.

The rise of the green bond market provides investors with an opportunity to take part in green projects and share the obligations and commitments related to climate change mitigation and adaptation (Puaschunder 2023; Liang 2023; Streimikiene et al. 2023). It is assumed that in the period until 2030, green finance will help preclude global CO_2 emissions equal to the current CO_2 emissions of the European Union and Japan combined (Alonso-Conde and Rojo-Suárez 2020; Glomsrød and Wei 2018). Researchers have observed a positive relationship between green bonds and green development (Kung et al. 2022), including the contribution of green bonds to growth of the economy by 4.9% and economy recovery by 17% on an annual basis (Zhao et al. 2022). The development of the green bond market contributes to the development of green growth (Tona et al. 2023).

Despite some established effects of green bonds on economic development, the scientific literature does not provide a large quantity of research on success factors, benefits, and challenges of issuing green bonds related to specific countries, from which some general conclusions could be drawn for certain market conditions, e.g., a smaller market, specific country, region, limited history of issuing green bonds in the country. We fill this research gap by analysing the success factors, benefits, and challenges of issuing green bonds in Lithuania. It is important to mention that no prior similar research on success factors, benefits, and challenges of issuing green bonds has been developed in Lithuania.

Therefore, this paper surveys the theoretical background behind the green bond concept and seeks to answer the following research questions: what are the success factors, benefits, and challenges of issuing green bonds in Lithuania? To establish the answer to the research question, we propose a conceptual model to establish success factors in issuing green bonds as well as the potential benefits and challenges of the issuance of green bonds in Lithuania.

We contribute to the existing literature in several ways. Firstly, the success factors, benefits, and challenges that have been discussed in the literature are summarized in the literature section to give a detailed overview of the analysed variables. These variables are evaluated via expert interviews to understand which success factors, benefits, and challenges of issuing green bonds are relevant for Lithuania. As a result, the study provides insights to the country-specific data, which can serve as a blueprint for issuers and decision-makers in other countries under similar market conditions.

The article consists of four sections. The first section investigates the evolution of the green bond market. The second section explains the research methods and establishes the concept of success factors relating to issuing green bonds, including potential benefits and challenges of the issuance of green bonds in Lithuania. The third section introduces the data collection process, and the fourth section covers the research findings. The fifth section reviews the research limitations and raises discussion points, followed by conclusions and guidelines for further research.

2. Literature Review

The history of events linked to the development of green bonds is summarised in Figure 1. The first green bonds were launched in 2007–2008 by the European Investment Bank and the International Bank for Reconstruction and Development, together with a reporting procedure.

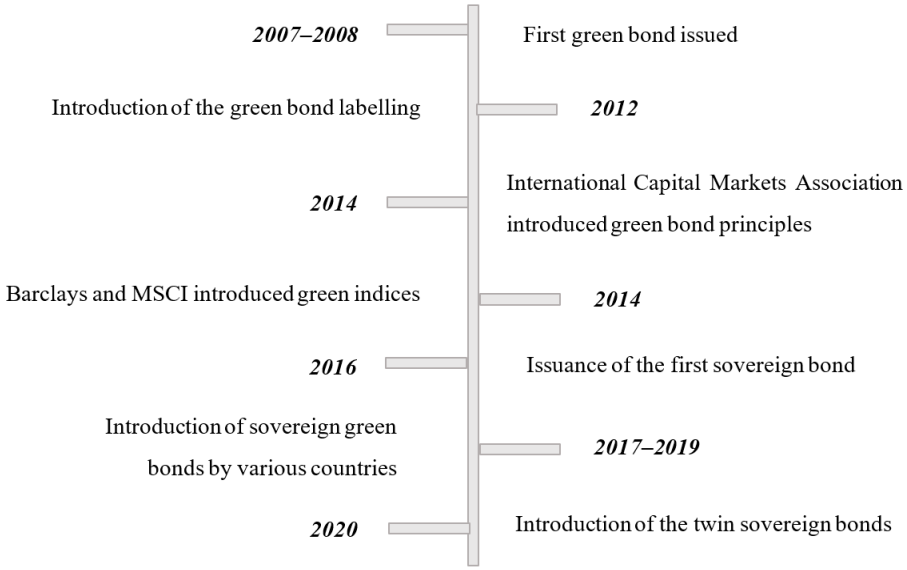

Figure 1. Evolution of the green bond market (source: compiled by author based on Cheong and Choi (2020) and Löffler et al. (2021).

In 2012, green bond labelling was introduced with the first certified climate bond from Belectric Solar. In 2014, Green Bond Principles were introduced by the International Capital Markets Association. In the same year, Barclays and MSCI introduced green indices. The first sovereign green bond was issued in 2016 by the government of Poland. In the subsequent years 2017–2019, various countries and exchanges introduced green bonds, including France, Fiji, Nigeria, Indonesia, Belgium, Lithuania, Ireland, the Netherlands, and Chile. In 2020, the German government issued twin sovereign bonds formed with a pairing of ordinary and green bonds. The twin bonds form a pair of ordinary and green bonds which have the same maturity and coupon rate, but the green bond is traded at yield to maturity which is lower at 2 bps. This indicates that investors agree to receive lower yields when holding green bonds in the portfolio (Löffler et al. 2021).

Many authors (Cheong and Choi 2020; Ehlers and Packer 2017; Fatica et al. 2019; Gilchrist et al. 2021; Inderst et al. 2012; Löffler et al. 2021; Migliorelli and Dessertine 2019; Tripathy et al. 2020) agree that green bonds are fixed-income instruments used to raise proceeds for projects of environmental preservation. More broadly, green bonds are used for the financing of green projects to reach green economic goals (Adekoya et al. 2021). Furthermore, green bonds may serve as a tool to reach global decarbonisation targets (Aneja et al. 2023; Sinha et al. 2021). At the corporate level, corporate green bonds can serve as an indicator of the company's efforts to confront environmental challenges (Flammer 2021).

Researchers (Otek Ntsama et al. 2021) observe that various authors provide slightly different explanations of green bonds; however, all of them can be summarised as having the following attributes: (1) green bonds can be issued by companies or governmental and international institutions to contribute to sustainable economic development; (2) green bonds are used to finance environmentally beneficial projects; (3) green bonds reflect the environmental standpoints and financial obligations of the issuers.

Academics have proposed several categories of green bonds (Cheong and Choi 2020; Hadas-Dyduch et al. 2022; Inderst et al. 2012): (1) asset-backed—used to finance large green projects; (2) corporate bonds—issued by companies pursuing environmental protection;

(3) bonds issued by large financial institutions for financing green projects; and (4) sovereign or municipal bonds.

In Lithuania, six green bonds are currently issued (Table 1). One green bond is issued by the government, and the rest are issued by companies. All issues of green bonds are certified by the International Capital Market Association's (ICMA) Green Bond Framework. It is important to mention that there are currently no green bonds issued by municipalities in Lithuania.

Table 1. Green bonds issued in Lithuania and traded on Nasdaq Baltic (source: compiled by authors based on Nasdaq Baltic).

Bond Type	ISIN	Issuer	Field	Use of Proceeds	Bond Type
Sovereign Green Bond	LT0000610305	Ministry of Finance of the Republic of Lithuania	Formulation and implementation of public finance policies	Green projects (modernisation of apartment buildings and energy efficiency)	Sovereign green bond
Corporate green bond	LT0000405938	UAB "Atsinaujinančios energetikos investicijos"	Collective investment undertaking for informed investors	Renewable solar and wind energy infrastructure projects, energy efficiency	Corporate green bond
Corporate green bond	LT0000406530	EPSO-G UAB	Energy	Electricity transmission via high voltage grids and natural gas transportation via high pressure pipelines	Corporate green bond
Corporate green bond	LT0000404238	AUGA group, AB	Agriculture	Ongoing sustainability projects, to finance solutions of GHG reductions	Corporate green bond
Corporate green bond	XS1646530565	AB "Ignitis grupė"	Energy	Investment in network segment and Green Generation projects	Corporate green bond
Corporate green bond	XS1853999313	AB "Ignitis grupė"	Energy	Investment in network segment and Green Generation projects	Corporate green bond

Green bonds are comparable to traditional bonds, but differences lie in the deal structure, requirements for reporting and auditing, and the allocation of proceeds (UNEP 2019). Green bonds bear the same characteristics as conventional bonds; however, these instruments involve pre- and post-issuance assurance that the issuance goals are well fulfilled (Pineiro-Chousa et al. 2021). Note that the proceeds raised through green bond issuance can only be used for environmentally sustainable projects (Naeem et al. 2022). The funds raised through the issuance of green bonds are typically used in sustainable energy and transportation, waste management projects, and other climate change mitigation initiatives (Ning et al. 2021). However, there is no formal requirement for the financing of green projects through a green bond issuance—such projects can also be financed by the issuance of conventional bonds (Lau et al. 2022).

Other characteristics of green bonds are related to the premium, yield, and spread of the bonds. Academics have observed that in contrast with positive premiums on bonds issued by private companies, green bonds issued by national governments, municipalities, or large financial institutions correspond to negative premiums (Bachelet et al. 2019; Migliorelli and Dessertine 2019; Kėdaitienė and Klyvienė 2020). Furthermore, scientists observe that municipal green bonds are issued with lower yields but at a premium on the US market (Baker et al. 2018). Moreover, Baker et al. (2018) and Löffler et al. (2021) observe that investors tend to give up a slight amount of yield to hold green bonds in their portfolio. Lastly, the 'green spread' is the difference in the yield of a green bond and a matched regular reference bond (Bongaerts and Schoenmaker 2019). Researchers have

discussed the differences in yields between conventional and green bonds. For example, academics (Sun et al. 2022a) explain that compared with conventional bonds, yields are lower for green bonds issued by non-financial and international companies, while there is no difference for green bonds issued by financial institutions.

Academics observe that there exist some prerequisites for the successful issuance of green bonds. Firstly, issuers of green bonds need to have a sound reputation (Bhutta et al. 2022; Cheng et al. 2022) and a good credit rating (Mankata et al. 2022) and ESG score (Cheng et al. 2022). Thus, the project to be financed by the issuance of green bonds needs to be financially sound (Mankata et al. 2022) and suitable requirements need to be selected for the project evaluation (Fatica and Panzica 2021). Furthermore, the issuer of green bonds should consider the size of the green bond issue as this also plays a role in successful issuance (Bhutta et al. 2022). Next, issuers should consider the clear use of proceeds disclosure, consistent reporting, and external review (Fatica and Panzica 2021). Lastly, the success of the green bond issue also depends on the provision of explicit country-level instruction for the issuance procedure (Mankata et al. 2022).

Researchers have observed numerous benefits of issuing green bonds. Firstly, green bonds can be applied to promote sustainability and green finance (Ning et al. 2021) and support government policies (Mankata et al. 2022). Green bonds may also help to increase investor interest in environmental financing and public awareness of environmental challenges and, consequently, public involvement in environmental protection (Mankata et al. 2022). On the other hand, green bonds correspond to the ability to raise large investment amounts needed to finance environmentally friendly projects, and such bonds bear more flexibility and liquidity and less investment risk (Wang 2021). Research conducted in India has shown that green bond issuances have positive effects on stock prices and investor sentiment (Verma and Bansal 2023). Thus, green bonds may help in the management of currency risks (Mankata et al. 2022). Moreover, green bonds help to obtain quantifiable and measurable benefits fromenvironmental preservation efforts (Mankata et al. 2022). On the issuer side, green bonds contribute to the amelioration of environmental performance and increase the ability of the issuer to produce new environmental technology and processes (Benlemlih et al. 2023), while on the investor side, green bonds help to strengthen the aptitudes of institutional investors (Mankata et al. 2022; Mathews and Kidney 2010).

Academics observe that there exist challenges related to the issuance of green bonds, such as greenwashing (Cheng et al. 2022) and additional issuance costs (Bongaerts and Schoenmaker 2019; Cheng et al. 2022). Furthermore, the importance of green bonds in environmental protection might be exaggerated, and they may provide only slight financial and economic benefits for investors willing to engage in projects supporting the environment (Bongaerts and Schoenmaker 2019). Lastly, the absence of global market standards might create additional challenges in the green bond issuance process (Bongaerts and Schoenmaker 2019).

In the following sections, this study investigates which of the selected above-mentioned success factors, benefits, and challenges of issuing green bonds are relevant for Lithuania.

3. Methodology

This study proposes a methodology for the establishment of success-dependent factors in issuing green bonds and the identification of potential benefits and challenges of issuance, which is based on the five-step process depicted in Figure 2. The first step of the research is analysis of the scientific literature on the issuance process of green bonds, as well as their potential challenges and benefits. In this work, significant emphasis is placed on the identification of the research criteria and defining the scope of the study. The scope of this research is separated into two parts: (1) research criteria that fall under pairwise comparison matrixes, (2) research criteria within the open questions section. The next step of the study includes the identification of persons who have solid expertise within the scope of the research, and involves structuring the research scope into the pairwise comparison matrix. The fourth step of the research is based on the application of the analytical hierarchy

process (AHP) method for the establishment of research variables that contribute significant importance, according to the experts. The final step of the research includes analysis of answers provided by experts to the open questions.

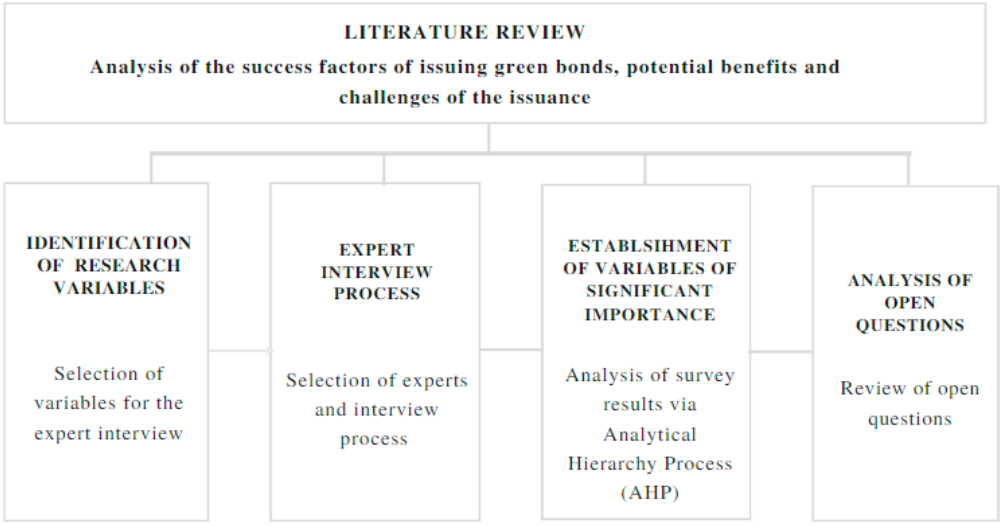

Figure 2. Conceptual model for the establishment of success factors of issuing green bonds, potential benefits, and challenges of their issuance in Lithuania (source: compiled by authors).

AHP is a widely used multi-criteria decision-making method that helps determine the weights of the criteria and prioritises alternatives with the help of pairwise comparison of selected criteria (Alrawad et al. 2023; Yan Liu et al. 2020). The AHP method originates from 1972 and was proposed by Saaty. Currently, the method is widely applied in environmental science, management studies, manufacturing, and engineering processes, and for the calculation of energy efficiency (Yu et al. 2021). One of the benefits of the AHP method is that it is applicable for analysis of qualitative and quantitative research questions. Thus, this multi-criterion decision-making method was applied in this study as the research variables are of a qualitative nature. Despite the wide applicability of the method, it has potential downsides—it involves the development of a considerable number of comparisons to make a decision (Leal 2020).

According to the method, the following qualities are attributable to the experts participating in the interview process (Saaty and Özdemir 2015): experts need to have considerable experience in the field of their judgment, experts also need to be consistent in their individual views on the research object they are going to judge, the knowledge of the experts needs to be sufficiently broad. The number of experts required for the evaluation of criteria varies in different studies: a single expert may be enough to make a judgement (Brunelli 2015), other studies have used 10 experts (Wang et al. 2018), 4 experts (Yap et al. 2017), 15 experts (Sevinç et al. 2018), or 13 experts (Petroutsatou et al. 2022).

The AHP method can be broken into five main steps (Elshafei et al. 2022; Sevinç et al. 2018; Vafaei et al. 2016; Vojtek and Vojteková 2019; Wang et al. 2018). However, in this research, the aim is to understand the significance of the selected research variables; therefore, the last step of the AHP method applied in this research was related to the determination of weights of the selected criteria, as no alternatives were analysed further.

1. Restructuring of the problem into a hierarchical structure. This includes the establishment of the goal of the problem and possible criteria and sub-criteria related to the problem.
2. Construction of the pairwise comparison matrix where selected criteria are compared using the rating scale. The multiple square matrices can be represented in the following manner (Yap et al. 2017):

$$C = [C_{ij}]_{nxn} \begin{bmatrix} C_{11} & C_{12} & C_{13} \\ C_{21} & C_{22} & C_{23} \\ C_{31} & C_{32} & C_{33} \end{bmatrix} \quad (1)$$

The reciprocal values can be represented in the following manner (Yap et al. 2017):

$$R = \left[\frac{1}{C_{ij}}\right]_{nxn} \begin{bmatrix} \frac{1}{C_{11}} & \frac{1}{C_{12}} & \frac{1}{C_{13}} \\ \frac{1}{C_{21}} & \frac{1}{C_{22}} & \frac{1}{C_{23}} \\ \frac{1}{C_{31}} & \frac{1}{C_{32}} & \frac{1}{C_{33}} \end{bmatrix} \quad (2)$$

The normalization of the pairwise comparison matrix can be represented in the following manner (Yap et al. 2017):

$$X_{ij} = \frac{C_{ij}}{\sum_{i=1}^{n} C_{ij}} \begin{bmatrix} X_{11} & X_{12} & X_{13} \\ X_{21} & X_{22} & X_{23} \\ X_{31} & X_{32} & X_{33} \end{bmatrix} \quad (3)$$

3. Determination of the weights of the criteria can be represented in the following manner (Yap et al. 2017):

$$W_{ij} = \frac{\sum_{j=1}^{n} X_{ij}}{n} \begin{bmatrix} W_{11} \\ W_{12} \\ W_{13} \end{bmatrix} \quad (4)$$

4. Determination of the consistency of the results. Herein, the consistency index is below 10%. Consistency ratio is computed by the flowing formula:

$$CR = \frac{CI}{RI} \quad (5)$$

where *CR*—consistency ratio, *CI*—consistency index, *RI*—random index. Random index value depends on the value of n, that is, the size of the pairwise comparison matrix. The random index values are summarized in Table 2.

Table 2. Randomised index values (source: compiled by authors based on Sevinç et al. (2018), Wang et al. (2018) and Yap et al. (2017)).

R	1	2	3	4	5	6	7	8	9	10
N	0	0	0.52	0.9	1.12	1.24	1.32	1.41	1.45	1.49

The consistency index is calculated via the application of the following formula:

$$CR = \frac{\lambda - n}{n - 1} \quad (6)$$

where n—number of criteria, λ—average value of the consistency vector.

The analysis of answers provided by the experts to the open questions is based on a qualitative assessment of the responses.

4. Results

The results section provides insights of the data collection process and obtained results via application of the analytical hierarchy process and summarises the answers to the open questions. Therefore, this section is respectively divided into corresponding subsections.

4.1. Data Collection Process

The data collection process began with the identification of experts taking part in the survey. Nine experts each with at least five years of experience in their field competency

were selected for participation in the survey (Table 3). The fields of competencies of the experts can be summarized in three broad areas: financial markets, sustainable finance, and ESG.

Table 3. Fields of expertise of respondents (source: compiled by authors).

Number of Experts	Area of Expertise
3	Financial markets
4	Sustainable finance
2	ESG

The identification of the scope of the research is based on an analysis of the literature on the notion of success-dependent factors for issuing green bonds and the interrelated benefits and challenges of their issuance. Based on the literature, the following research criteria were identified for the construction of a pairwise comparison matrix of the success-dependent factors for issuing green bonds:

1. Good credit rating (Mankata et al. 2022);
2. Provision of explicit country-level instruction on the issuance procedure (Mankata et al. 2022);
3. Suitable requirements for green project eligibility (Mankata et al. 2022);
4. Precedence given to financially sound projects (Mankata et al. 2022);
5. Transparent and clearly defined use and management of proceeds (Fatica and Panzica 2021);
6. Process for project evaluation and selection (Fatica and Panzica 2021);
7. Reporting and external review (Fatica and Panzica 2021);
8. Reputation of the issuer (Bhutta et al. 2022; Cheng et al. 2022);
9. ESG score (Cheng et al. 2022);
10. Size of the green bond issue (Bhutta et al. 2022).

Based on the literature, the following research criteria were identified for the construction of a pairwise comparison matrix of the benefits of issuing green bonds:

1. Instrument for the management of currency risks (Mankata et al. 2022);
2. Increase of investor interest in environmental financing (Mankata et al. 2022);
3. Strengthening the aptitude of institutional investors (Mankata et al. 2022);
4. Provision of quantifiable and measurable benefits (Mankata et al. 2022);
5. Supporting government policies (Mankata et al. 2022);
6. Stimulation of public involvement (Mankata et al. 2022);
7. Creating and stabilising an efficient bond market (Mankata et al. 2022);
8. Low investment risks (Wang 2021);
9. Ability to raise large investment amounts needed to finance environmentally friendly projects (Wang 2021);
10. Bonds bear more flexibility and liquidity (Wang 2021).

Based on the scientific literature, the following research criteria were identified for the construction of the pairwise comparison matrix of the challenges of issuing green bonds:

1. Greenwashing (Cheng et al. 2022);
2. The green bond market might exaggerate its own importance in terms of environmental protection (Bongaerts and Schoenmaker 2019);
3. Green bonds provide slight financial and economic benefits for investors willing to engage into projects supporting the environment (Bongaerts and Schoenmaker 2019);
4. Issuance costs (Bongaerts and Schoenmaker 2019; Cheng et al. 2022)
5. Absence of global market standards (Bongaerts and Schoenmaker 2019).

The experts participating in the survey were asked to fill the three pairwise comparison matrixes for identification of success factors, benefits, and challenges of issuing green bonds in relation to the above-mentioned criteria. The experts were asked to evaluate the significance of these criteria to Lithuania, based on the Saaty rating scale (Table 4).

Table 4. Saaty rating scale (source: compiled by authors based on Alrawad et al. 2023; Leal 2020; Sevinç et al. 2018; Yap et al. 2017).

Intensity of Importance	Definition
1	Equal importance
3	Moderate importance
5	Strong importance
7	Very strong importance
9	Extreme importance
2, 4, 6, 8	Intermediate values

The experts were also asked to share their views on the following open questions:

1. What in your view makes a credible green bond?
2. What could be other most important success criteria for issuing green bonds in Lithuania?
3. What could be other benefits of issuing green bonds in Lithuania?
4. What could be other challenges of issuing green bonds in Lithuania?
5. Would understanding of the green value added by the green bond issuance help to contribute to its success?
6. How could the impact or success of the green bond be enhanced?

4.2. Research Results Obtained via Analytical Hierarchy Process

The results of the survey on the establishment of success factors in issuing green bonds and the potential benefits and challenges of the issuance according to the proposed conceptual model are summarised in Tables 5–7. The results are outlined by experts, with corresponding weights and the final weights measured in percentages. The consistency ratios that correspond to the answers of specific experts fulfil the requirement of falling under 10% (Yap et al. 2017).

The following criteria were evaluated by experts to understand the success factors of issuing green bonds in Lithuania (Table 5): (1) good credit rating of the issuer, (2) provision of clear country-level guidance on the issuance procedure, (3) suitable requirements for green project eligibility, (4) precedence for financially sound projects, (5) transparent and clearly defined use and management of proceeds, (6) process for project evaluation and selection, (7) reporting and external review, (8) reputation of the issuer, (9) ESG score of the issuer, (10) size of the green bond issue. The abbreviations "Ex.1–Ex.9" correspond to the expert, and the "FW" stands for the final weight of the criteria. According to experts, the most significant criteria to issue a green bond successfully are:

1. Reputation of the issuer (17%);
2. Good credit rating of the issuer (15%);
3. ESG score of the issuer (12%);
4. Suitable requirements for green project eligibility (11%);
5. Precedence for financially sound projects (11%);
6. Process for project evaluation and selection (10%).

The following criteria were evaluated by experts to explain the benefits of issuing green bonds in Lithuania (Table 6): (1) using green bonds as an instrument for managing currency risk, (2) developing investor interest in environmental financing, (3) strengthening the aptitude of institutional investors, (4) providing quantifiable and measurable benefits, (5) supporting government policies, (6) stimulating the involvement of the public, (7) creating and stabilising efficient bond markets, (8) offering low investment risks, (9) raising large investment amounts needed to finance environmentally friendly projects, and (10) adding more flexibility to bonds. According to experts, the most significant benefits of green bond issuance are:

1. Using green bonds as an instrument for managing currency risks (16%);

2. Raising large investment amounts needed to finance environmentally friendly projects (14%);
3. Providing quantifiable and measurable benefits (13%);
4. Creating and stabilising efficient bond markets (12%);
5. Stimulating the involvement of the public (10%).

Table 5. Results of the pairwise comparison matrix for success factors of issuing green bonds (source: compiled by authors).

Criteria	Ex. 1, %	Ex. 2, %	Ex. 3, %	Ex. 4, %	Ex. 5, %	Ex. 6, %	Ex. 7, %	Ex. 8, %	Ex. 9, %	FW
Good credit rating	21.4	15.3	17.8	19.8	20.0	19.8	7.0	5.8	6.8	15
Provision of explicit country-level instruction on the issuance procedure	2.7	2.8	2.2	2.5	2.7	2.3	11.1	9.6	6.5	5
Suitable requirements for green project eligibility	10.1	10.7	8.2	11.8	9.7	8.9	12.0	16.0	15.4	11
Precedence given to financially sound projects	11.4	10.6	11.1	13.7	10.7	12.4	11.4	9.0	8.9	11
Transparent and clearly defined use and management of proceeds	4.6	5.4	4.7	4.0	4.7	4.6	14.9	13.1	12.6	8
Process for project evaluation and selection	5.3	6.8	5.1	4.4	6.4	5.4	17.5	18.6	17.2	10
Reporting and external review	6.2	6.5	6.8	6.4	7.5	5.6	7.5	5.0	5.8	6
Reputation of the issuer	17.5	19.2	22.4	18.9	19.4	22.2	7.5	11.3	16.6	17
ESG score	13.8	14.8	15.2	11.9	12.4	11.67	7.9	8.9	8.1	12
Size of the green bond issue	7.0	8.0	6.4	6.8	6.5	7.2	3.2	2.7	2.0	6
Consistency	0.7	0.1	5.5	1.00	4.4	4.7	9.5	9.5	8.4	

Table 6. Results of the pairwise comparison matrix for benefits of issuing green bonds (source: compiled by authors).

Criteria	Ex. 1, %	Ex. 2, %	Ex. 3, %	Ex. 4, %	Ex. 5, %	Ex. 6, %	Ex. 7, %	Ex. 8, %	Ex. 9, %	FW
Instrument for management of the currency risks	6.6	6.62	6.7	8.8	8.3	7.5	7.9	3.0	1.6	6
Increase of investor interest in environmental financing	4.6	4.57	3.9	4.2	4.5	4.2	4.3	17.9	5.2	6
Strengthen aptitude of institutional investors	3.9	3.87	3.1	3.1	3.2	3.4	3.4	19.7	6.0	6
Provision of quantifiable and measurable benefits	13.9	13.91	10.8	14.8	13.5	14.7	14.8	2.7	17.8	13
Supporting government polices	9.99	9.99	11.1	9.99	9.8	10.1	10.8	7.9	4.8	9
Stimulation of involvement of the public	11.6	11.63	7.8	7.2	7.9	8.4	8.7	18.2	6.7	10
Creating/stabilising efficient bond market	13.7	13.66	13.0	11.6	12.5	13.0	11.9	4.1	14.1	12
Low investment risks	16.2	16.18	14.8	18.4	20.0	17.7	14.8	3.2	19.1	16
Ability to raise large investment amounts needed to finance environmentally-friendly projects	9.9	9.93	15.8	11.2	10.6	11.3	13.4	18.3	21.4	14
Bonds bear more flexibility and liquidity	9.6	9.64	13.5	10.6	9.7	9.7	10.0	4.9	3.4	9
Consistency	0.8	0.8	9.9	9.0	9.5	8.0	8.5	8.1	6.4	

Table 7. Results of the pairwise comparison matrix for challenges of issuing green bonds (source: compiled by authors).

Criteria	Ex. 1, %	Ex. 2, %	Ex. 3, %	Ex. 4, %	Ex. 5, %	Ex. 6, %	Ex. 7, %	Ex. 8, %	Ex. 9, %	FW
Greenwashing	53.1	51.2	45.8	45.6	44.1	35.2	10.2	29.0	32.6	39
Green bond market might exaggerate its importnce in environmental protection	25.8	23.3	28.8	20.1	22.6	20.7	6.5	28.4	32.6	23
Green bonds provide slight financial and economic benefits for investors willing to engage into projects supporting the environment	6.0	10.5	11.3	16.5	16.3	23.4	7.6	29.0	18.0	15
Issuance costs	10.60	9.9	8.01	11.6	11.4	13.8	7.6	8.5	12.3	10
Absence of global market standards	4.6	5.2	6.1	6.1	5.7	6.9	68.1	5.1	4.7	12
Consistency	7.2	7.1	4.7	6.6	8.2	8.2	3.5	0.6	8.1	

The following criteria were evaluated by experts to explain the challenges of issuing green bonds in Lithuania (Table 7): (1) greenwashing, (2) the green bond market might exaggerate its own importance in environmental protection, (3) green bonds provide slight financial and economic benefits for investors willing to engage into projects supporting the environment, (4) issuance costs, (5) absence of global market standards. According to the experts, the biggest challenges associated with issuing green bonds include:

1. Greenwashing (39%);
2. The green bond market might exaggerate its role in environmental protection (23%);
3. Green bonds provide slight financial and economic benefits for investors willing to engage in projects supporting the environment (15%);
4. Absence of global market standards (12%).

4.3. Research Results Obtained via Open Questions

The first open question covered the perceptions of experts on the credibility of green bonds. Experts suggest that reputation, ESG score, and credit rating are crucial criteria in green bonds' reliability. Thus, considerable importance is placed on the comprehensive project goal that will be financed by the issued green bond, along with clarity of the project management approach and the use of proceeds. It is important to mention that experts observed the importance of a green bond's reliance on international certification standards (e.g., ICMA) or the EU taxonomy regulation (Regulation 2020/852 of the European Parliament and of the Council of 18 June 2020) and the related EU Green Bond Standard (EUGBS). Additionally, the benefits of the green bond issue should be well-defined with a focus on sustainability and protection of the environment.

The second question covered the perception of experts on the other success criteria of green bond issuance in Lithuania. Experts suggested the importance of clear communication of various factors relating to green bond issuance (e.g., purpose, outcomes of the project, contribution to sustainability or environmental protection) to investors and the public. Such communication could be arranged with a wider scope through a promotional campaign. Experts also observed that governmental support should correspond to the success of green bond issuance. Experts agreed that promotion of green finance, green bonds as financing mechanisms, and green investment is needed on a country level, and such governmental efforts would correspond to the success of green bond issuance. Lastly, experts suggest that the adoption of best practices for issuing green bonds from market players involved in such issuances for a considerable time would also help to increase their potential success.

The third open question covered the perception of experts on the other benefits of green bond issuance in Lithuania. Here, experts agreed that the issuance of green bonds

was associated with increased activity of the financial market in Lithuania, corresponding to increased variety of financial products available for investors. The issuance of green bonds would also help to diversify of investors' portfolios. Thus, green bond issuance helps to raise funds for various types of projects: (1) those focused on sustainability and environmental preservation, (2) projects that present challenges for obtaining funding, (3) projects financed via loans. Furthermore, green bond issuance helps to raise awareness of environmental challenges and to educate the public about green finance.

The fourth open question covered the perception of experts on the other challenges relating to green bond issuance in Lithuania. The experts in this study agreed that the attractiveness of the issued green bond may be influenced by the small local market and limited local financial potential, whereas opportunities to attract foreign investors might be insufficient. On the investor side, the experts reported reliability concerns related to project transparency, the clear use of proceeds, and benefits from the projects. On the issuer's side, experts pointed out challenges in meeting the green bond certification standards, data availability, and distrust from possible investors coupled with insufficient knowledge and proficiency of investors in green finance. Finally, the experts also pointed out a lack of confidence in green bonds from the general public, which might be related to the issue of a lack of available information for a wider audience.

The fifth open question relates to the perception of experts in understanding the green value added by green bonds and its contribution to the success of the issuance. All experts agreed that the value added by the issued green bonds would undoubtedly be a beneficial measure to improve understanding of green bonds. This result implies that additional valuation measures could be considered for future development.

The sixth open question concerns the perception of experts on the enhancement of the impact or success of green bond issuance in Lithuania. Experts proposed that governmental support along with the promotion of green finance and green bonds on a broader scale is necessary for successful green bond issuance in Lithuania. The significance of informational and education campaigns was noted. Experts also suggested that clear communication of various factors relating to green bond issuance (e.g., purpose, outcomes of the project, contribution to sustainability or environmental protection, impact assessment, benefits tracking) by reputable process stakeholders should increase the chances of its success.

5. Discussion

This study provides insights into the success factors, benefits, and challenges of green bond issuance in Lithuania. The results can be summarised considering the perceptions of the issuers of green bonds and potential investors.

Factors relevant to the issuer when deciding to issue a green bond in Lithuania are related to the suitability of requirements for green project eligibility and processes for project evaluation and selection. Note that this study has revealed that precedence for financially sound projects should be considered; the practice of environmentally beneficial projects is usually based on the economic benefits of the projects as they do not invite substantial financial returns. Furthermore, potential green bond issuance should be based on certification standards (e.g., ICMA, EU Green Bond Standard (EUGBS)) and the adoption of best practices in issuing green bonds from experienced and reputable market players. These certification standards should be taken as a reference point for successful green bond issuance. Finally, from the issuer's perspective, the promotion of green finance and green bonds by the government is a significant factor when deciding to issue a green bond, as these help to attract local and foreign investors. Factors important to the investor when deciding whether to invest in a green bond in Lithuania are mainly related to the state of the issuer, for instance, whether the issuer is reputable as well as their credit rating and ESG score. When engaging with green bonds, investors value the clear communication of various factors relating to the green bond issuance (e.g., purpose, outcomes of the project, potential benefits, use of proceeds, certification, contribution to sustainability or environmental protection).

The benefits of the issuing green bonds in Lithuania from the perspective of the issuers can be summarised in reference to projects that can be potentially financed by the green bonds, such as projects focused on sustainability and environmental preservation, projects that encounter challenges obtaining funding, or projects financed via loans. Another benefit for the issuer of the green bonds is the ability to raise large investment amounts needed to finance environmentally friendly projects. Studies show that green bonds help to reduce the cost of debt (Hussain et al. 2022; Teti et al. 2022), which is beneficial for the financing of large projects. The benefits of investing in bonds in Lithuania from an investor's perspective are related to the increased efficiency of the bond market, increased variety of fixed-income products, improved portfolio diversification, and low investment risks. The benefits of diversification have been identified by researchers (Chopra and Mehta 2023; Elsayed et al. 2022; Maino 2022; Naeem et al. 2022, 2023; Tiwari et al. 2023). Studies of portfolios including green and conventional bonds in the USA and Europe showed that green bonds help increase returns and reduce volatility (Baranowski and Kopnina 2022; Han and Li 2022). Researchers also observe that holding green bonds until maturity might be a beneficial strategy for investors to overcome liquidity concerns (Boutabba and Rannou 2022).

Challenges related to green bond issuance in Lithuania from the perspective of the issuer are associated with the potential of the green bond issuance to obtain anticipated results. Market-specific factors such as its size, financial potential, and limited opportunities to attract foreign investors are currently the major challenges in the market. Similar situations of difficulties in attracting foreign investors have been observed in the Czech Republic, Hungary, Poland, and Slovakia (Hadas-Dyduch et al. 2022). Other potential investor challenges include the absence of unified market-certification standards, which makes it difficult to meet certification requirements. The same challenges relating to a lack of international certification have been observed in Europe (Nikolaj et al. 2022) and Asian countries (Jain et al. 2022). Data availability and consistency related to environmental variables is also a major of concern for issuers. The same data challenges are also evident in studies of Northern Europe (Tona et al. 2023). Finally, potential investor sentiment such as a lack of trust in green bonds is also a challenge for issuers, considering that the knowledge and expertise of potential investors in the green bond market can be improved.

Challenges related to the green bond issuance in Lithuania from the perspective of the investor are related to the potential greenwashing that can be associated with green bonds and to the extent of the contribution of the green bond market to environmental protection. On the one hand, greenwashing is considered to be a threat to the further development of the green bond market (Lin and Hong 2022; Maino 2022). On the other hand, potential investors might be able to understand in greater detail the financial and economic benefits of projects supporting the environment, and may be willing to engage with these through the acquisition of green bonds.

Research on the availability and readability of green bond issuance documentation has a positive effect on the liquidity of green bonds (Lebelle et al. 2022). The absence of global market standards can also raise reliability concerns related to project transparency, the clear use of proceeds from green projects, and their benefits to potential investors. A lack of global or local standards has been noted as a challenge in the Czech Republic, Hungary, Poland, Slovakia (Hadas-Dyduch et al. 2022), Asia (Jain et al. 2022), and India (Kumar 2022a).

Experts who participated in this survey emphasized the importance of communication and information availability for investors and the general public as part of the success of a green bond issuance. The significance of the availability of information and awareness of the benefits of green bonds was also apparent in the Czech Republic, Hungary, Poland, Slovakia (Hadas-Dyduch et al. 2022), and other countries (Ozili 2022; Štreimikienė et al. 2022). The following aspects should be considered by issuers of green bonds in Lithuania when establishing communication about green bonds: (1) the purpose of the issuance and its potential environmental benefits, (2) the outcomes of the project being financed by the green bond, (3) the use of proceeds, (4) certification, (5) the contribution to sustainability or environmental protection, and (6) the environmental challenges faced by the issuer.

In addition, with the increasing level of public participation in green bonds, the government of Lithuania could contribute to the promotion of green finance and green bonds by focusing on these areas: (1) information readiness for varied audiences, including potential investors and the general public, (2) raising awareness of the environmental challenges, (3) the importance of green finance in environmental protection, (4) green finance mechanisms, (5) benefits of the green bond issue, and (6) how to understand and detect greenwashing.

This research has also showed the applicability of the AHP method for the selected survey. Alternative methods which can be applied for similar studies instead of AHP can include application of fuzzy AHP (Yadi Liu et al. 2023). In contrast, as the green bond market in Lithuania becomes more mature and more data becomes available, the comparison of results could be consequentially developed. An applicable method may be principal component analysis, which is widely applied in multivariate analysis (Ghojogh et al. 2023; Jolliffe 2022). Principal component analysis is used in various fields such as finance (Battisti et al. 2022; Kumar 2022b; Malik et al. 2022), economics (Mohsin et al. 2022; Sun et al. 2022b), forecasting (Chang et al. 2022; Dai 2022), medical studies (Gupta et al. 2022; Jiang et al. 2022), machinery (Palit et al. 2022).

Based on the findings of this research, several recommendations and practical implications can be made for potential issuers, investors, and policymakers interested in promoting sustainable and green finance. Firstly, issuers should prioritize their reputation, credit rating, and environmental, social, and governance score to increase the likelihood of successful green bond issuance. Issuers should avoid greenwashing, by providing transparent and accurate information about the environmental impact of their projects. Researchers (Torvanger et al. 2021) observe that the success and development of the green bond market depends on collaboration between the issuers of green bonds and potential investors, effective communication, and transparent disclosure of green finance activities. Thus, investors should carefully evaluate green bond issuers to ensure they are committed to sustainable and environmentally responsible practices. Furthermore, policymakers should encourage the development of green bond markets by providing regulatory support and financial incentives. As noted by Mr Mark Carney, Governor of the Bank of England and Chairman of the Financial Stability Board, in his speech at Lloyd's of London, governments should lead to the transition to the low carbon economy (Carney 2015).

6. Limitations and Future Research Recommendations

The limitations of this research are mainly related to the scope of the success factors, benefits, and challenges of issuing green bonds. As more studies are published by researchers, more new research variables might appear which may be useful to test in terms of their relevance for Lithuania. As a result, one of the future research dimensions could be the evaluation of new success factors, benefits, and challenges of issuing green bonds in Lithuania, based on the findings of other scholars.

Another limitation of the study may relate to the number of experts participating in the survey. Although the selected method for the analysis of expert opinion does not require a large number of respondents, the current study employed the opinion of nine experts. Currently, as green bond issuance is a relatively new topic in Lithuania, the selected number of respondents seems to be sufficient as the number of professionals working in this field is limited. However, as the green bond concept evolves within the country and the number of professionals involved in the issuance of green bonds potentially might increase, similar research with the involvement of a broader audience of experts can be carried out on the success factors, benefits, and challenges of issuing green bonds.

It is important to mention a relevant factor as a limitation of the current research. At the current stage of development of the green bond market in Lithuania, which is still a niche market, the proposed survey is relevant and provides value for issuers, investors, and policy makers. However, after some time, when the green bond market becomes more mature, the identified attributes of success for issuing green bonds, their benefits, and

challenges might not remain relevant or may change. Therefore, similar research could be carried out in the future under more mature green bond market conditions.

Moreover, another limitation can be attributed to the significance of the study for a particular country. Based on the discussion points covered in the study, some similarities can be drawn between countries sharing similar attributes (e.g., population, GDP, development of the green bond market, etc.); it is still worth proving the suitability of such generalizations. One of the dimensions of future research could focus on the comparison of the situation within the region. This would include the development of similar research in Latvia and Estonia and establishing an understanding of whether selected research variables provide similar results within the region.

Thus, the current research could be supplemented with the findings from the lessons learned about the current issues affecting green bonds, as described in the literature review. Although the current coverage of the research variables affecting the success factors, benefits, and challenges of issuing green bonds already covers insights from actual issuance experience, more detailed analysis of technicalities would be also beneficial. Therefore, future research could focus on the actual and in-depth know-how of the green bond issuance process and its peculiarities in Lithuania, taking into account dependence on the issuer type.

Finally, future research can also focus on the potential financial and economic benefits of issuing green bonds in Lithuania. This would help to bring more clarity for prospective issuers on exact benefits and would help to navigate them towards a decision on issuance.

7. Conclusions

The importance of sustainable and green finance is growing and gaining attention globally. Green finance is considered to be an innovative way to finance green growth. One of the challenges of green finance is the effective allocation of funds to green projects initiated by various players in the economy, such as private, public, and other market participants (Ning et al. 2021). Academics have observed that green finance contributes to the ecological advancement of the economy (Zhou and Xu 2022). Moreover, researchers state that optimal construction of an investment portfolio of green finance solutions can serve as an efficient tool for the acquisition of funds necessary for addressing environmental and ecological challenges.

In 2019, the European Commission developed a structural reform support programme (SRSP) for Lithuania, acknowledging the active involvement of the country in green finance yet simultaneously indicating that the current level of funds raised through green finance products is unsustainable in the long run (European Commission 2019). Considering efforts to restructure the regulatory environment in order to promote the development of the green bond market, this paper has aimed to identify the success factors, benefits, and challenges of issuing green bonds in Lithuania and to fill the gaps in the scientific literature on the research variables in the region or in countries of similar size or economic conditions.

Results of the study prove the importance of green bonds in innovative economic policy and the rise of green finance markets. First, this research has revealed that the reputation, good credit rating, ESG score of the issuer, qualification criteria for green projects, the process of evaluation, the selection of projects, and the prioritisation of these projects as financially viable are the key components of a successful green bond issuance. Second, on the benefits side, green bond issuances correspond to low investment risks, the ability to raise large investment amounts, the provision of tangible added benefits, the creation and stabilisation of an efficient bond market, and the promotion of public participation. Finally, however, green bonds issues face challenges such as an absence of global market standards, greenwashing, a questionable role in environmental protection, and dubious financial and economic benefits.

The study also highlighted the applicability of the analytical hierarchy process method and expert survey as valuable tools for assessing the factors that influence sustainable finance. The methodology proposed in the study and findings can serve as a basis for

future research that explores the factors that influence sustainable finance and can help to advance the understanding of this field.

Overall, our study confirmed the important roles of green bonds as an instrument of the green finance market. As a result, the research provides important practical implications for policy makers, issuers, and investors in green bonds in Lithuania. In order to further develop the research, proposals are suggested including the comparison of research findings with those from other countries. The evidence calls for rethinking public intervention in the green finance market.

Author Contributions: Conceptualization, J.B. and J.S.; methodology, J.B.; validation, J.B. and J.S.; formal analysis, J.B.; investigation, J.B.; writing—original draft preparation, J.B.; writing—review and editing, J.S.; visualization, J.B.; supervision, J.S. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Conflicts of Interest: The authors declare no conflict of interest.

References

Adekoya, Oluwasegun B., Johnson A. Oliyide, Mahdi Ghaemi Asl, and Saba Jalalifar. 2021. Financing the green projects: Market efficiency and volatility persistence of green versus conventional bonds, and the comparative effects of health and financial crisis. *International Review of Financial Analysis* 78: 101954. [CrossRef]

Alonso-Conde, Ana-Belén, and Javier Rojo-Suárez. 2020. On the Effect of Green Bonds on the Profitability and Credit Quality of Project Financing. *Sustainability* 12: 6695. [CrossRef]

Alrawad, Mahmaod, Abdalwali Lutfi, Mohammed Amin Almaiah, Adi Alsyouf, Akif Lutfi Al-Khasawneh, Hussin Mostafa Arafa, Nazar Ali Ahmed, Ahmad M. AboAlkhair, and Magdy Tork. 2023. Managers' Perception and Attitude toward Financial Risks Associated with SMEs: Analytic Hierarchy Process Approach. *Journal of Risk and Financial Management* 16: 86. [CrossRef]

Aneja, Ranjan, Shine Raju Kappil, Narasingha Das, and Umer Jeelanie Banday. 2023. Does the green finance initiatives transform the world into a green economy? A study of green bond issuing countries. *Environmental Science and Pollution Research* 30: 42214–22. [CrossRef] [PubMed]

Bachelet, Maria Jua, Leonardo Becchetti, and Stefano Manfredonia. 2019. The green bonds premium puzzle: The role of issuer characteristics and third-party verification. *Sustainability* 11: 1098. [CrossRef]

Baker, Malcolm, Daniel Bergstresser, George Serafeim, and Jeffrey Wurgler. 2018. Financing the Response to Climate Change: The Pricing and Ownership of U.S. Green Bonds. *SSRN Electronic Journal*, 1–44. [CrossRef]

Banga, Josué. 2019. The green bond market: A potential source of climate finance for developing countries. *Journal of Sustainable Finance and Investment* 9: 17–32. [CrossRef]

Baranowski, Mariusz, and Helen Kopnina. 2022. Socially responsible consumption: Between social welfare and degrowth. *Economics and Sociology* 15: 319–35. [CrossRef]

Battisti, Enrico, Simona Alfiero, Roberto Quaglia, and Dorra Yahiaoui. 2022. Financial performance and global start-ups: The impact of knowledge management practices. *Journal of International Management* 28: 100938. [CrossRef]

Benlemlih, Mohammed, Jamil Jaballah, and Lamya Kermiche. 2023. Does financing strategy accelerate corporate energy transition? Evidence from green bonds. *Business Strategy and the Environment* 32: 878–89. [CrossRef]

Bhutta, Umair Saeed, Adeel Tariq, Muhammad Farrukh, Ali Raza, and Muhammad Khalid Iqbal. 2022. Green bonds for sustainable development: Review of literature on development and impact of green bonds. *Technological Forecasting and Social Change* 175: 121378. [CrossRef]

Bongaerts, Dion, and Dirk Schoenmaker. 2019. The Next Step in Green Bond Financing. *SSRN Electronic Journal*, 1–11. [CrossRef]

Boutabba, Mohamed Amine, and Yves Rannou. 2022. Investor strategies in the green bond market: The influence of liquidity risks, economic factors and clientele effects. *International Review of Financial Analysis* 81: 102071. [CrossRef]

Brunelli, Matteo. 2015. Introduction to the Analytic Hierarchy Process. In *SpringerBriefs in Operations Research*. Cham: Springer. [CrossRef]

Carney, Mark. 2015. Breaking the Tragedy of the Horizon—Climate Change and Financial Stability—Speech by Mark Carney | Bank of England. Bank of England, pp. 1–16. Available online: https://www.bankofengland.co.uk/speech/2015/breaking-the-tragedy-of-the-horizon-climate-change-and-financial-stability (accessed on 29 April 2023).

Chang, Li-Chiu, Jia-Yi Liou, and Fi-John Chang. 2022. Spatial-temporal flood inundation nowcasts by fusing machine learning methods and principal component analysis. *Journal of Hydrology* 612: 128086. [CrossRef]

Cheng, Louis TW, Piyush Sharma, and David C. Broadstock. 2022. Interactive effects of brand reputation and ESG on green bond issues: A sustainable development perspective. *Business Strategy and the Environment* 32: 570–86. [CrossRef]
Cheong, Chiyoung, and Jaewon Choi. 2020. Green bonds: A survey. *Journal of Derivatives and Quantitative Studies* 28: 175–89. [CrossRef]
Chopra, Monika, and Chhavi Mehta. 2023. Going green: Do green bonds act as a hedge and safe haven for stock sector risk? *Finance Research Letters* 51: 103357. [CrossRef]
Dai, Wensheng. 2022. Application of Improved Convolution Neural Network in Financial Forecasting. *Journal of Organizational and End User Computing (JOEUC)* 34: 1–16. [CrossRef]
Ehlers, Torsten, and Frank Packer. 2017. Green Bond Finance and Certification. *BIS Quarterly Review*, 89–104.
Elsayed, Ahmed H., Nader Naifar, Samia Nasreen, and Aviral Kumar Tiwari. 2022. Dependence structure and dynamic connectedness between green bonds and financial markets: Fresh insights from time-frequency analysis before and during COVID-19 pandemic. *Energy Economics* 107: 105842. [CrossRef]
Elshafei, Ghada, Dušan Katunský, Martina Zeleňáková, and Abdelazim Negm. 2022. Opportunities for Using Analytical Hierarchy Process in Green Building Optimization. *Energies* 15: 4490. [CrossRef]
European Commission. 2019. Sustainable Finance Action Plan for Lithuania. Available online: https://reform-support.ec.europa.eu/what-we-do/green-transition/sustainable-finance-action-plan-lithuania_en (accessed on 18 March 2023).
Fatica, Serena, and Roberto Panzica. 2021. Green bonds as a tool against climate change? *Business Strategy and the Environment* 30: 2688–701. [CrossRef]
Fatica, Serena, Roberto Panzica, and Michela Rancan. 2019. The Pricing of Green Bonds: Are Financial Institutions Special? *Journal of Financial Stability* 54: 100873. [CrossRef]
Flammer, Caroline. 2021. Corporate green bonds. *Journal of Financial Economics* 142: 499–516. [CrossRef]
García, C. José, Begoña Herrero, José Luis Miralles-Quirós, and Maria del Mar Miralllles-Quirós. 2023. Exploring the determinants of corporate green bond issuance and its environmental implication: The role of corporate board. *Technological Forecasting and Social Change* 189: 122379. [CrossRef]
Ghojogh, Benyamin, Mark Crowley, Fakhri Karray, and Ali Ghodsi. 2023. Principal Component Analysis. In *Elements of Dimensionality Reduction and Manifold Learning*. Cham: Springer International Publishing, pp. 123–54. [CrossRef]
Gilchrist, David, Jing Yu, and Rui Zhong. 2021. The Limits of Green Finance: A Survey of Literature in the Context of Green Bonds and Green Loans. *Sustainability* 13: 478. [CrossRef]
Glomsrød, Solveig, and Taoyuan Wei. 2018. Business as unusual: The implications of fossil divestment and green bonds for financial flows, economic growth and energy market. *Energy for Sustainable Development* 44: 1–10. [CrossRef]
Gupta, Varun, Monika Mittal, Vikas Mittal, and Yatender Chaturvedi. 2022. Detection of R-peaks using fractional Fourier transform and principal component analysis. *Journal of Ambient Intelligence and Humanized Computing* 13: 961–72. [CrossRef]
Hadas-Dyduch, Monika, Blandyna Puszer, Maria Czech, and Janusz Cichy. 2022. Green Bonds as an Instrument for Financing Ecological Investments in the V4 Countries. *Sustainability* 14: 12188. [CrossRef]
Han, Yingwei, and Jie Li. 2022. Should investors include green bonds in their portfolios? Evidence for the USA and Europe. *International Review of Financial Analysis* 80: 101998. [CrossRef]
Hussain, Hafezali Iqbal, Fakarudin Kamarudin, Jason J. Turner, Hassanudin Mohd Thas Thaker, and Nazratul Aina Mohamad Anwar. 2022. Environmnetal Reporting Policy and Debt Maturity: Perspectives from a Developing Country. *Transformations in Business and Economics* 22: 245–62.
Inderst, Georg, Christopher Kaminker, and Fiona Stewart. 2012. *Defining and Measuring Green Investments: Implications for Institutional Investors' Asset Allocations*. Paris: OECD Publishing. [CrossRef]
Jain, Kriti, Medha Gangopadhyay, and Kakali Mukhopadhyay. 2022. Prospects and challenges of green bonds in renewable energy sector: Case of selected Asian economies. *Journal of Sustainable Finance and Investment*. [CrossRef]
Jiang, Lin, Hunter Sullivan, and Bo Wang. 2022. Principal Component Analysis (PCA) Loading and Statistical Tests for Nuclear Magnetic Resonance (NMR) Metabolomics Involving Multiple Study Groups. *Analytical Letters* 55: 1648–62. [CrossRef]
Jolliffe, Ian. 2022. A 50-year personal journey through time with principal component analysis. *Journal of Multivariate Analysis* 188: 104820. [CrossRef]
Kėdaitienė, Angelė, and Violeta Klyvienė. 2020. The Relationships between Economic growth, Energy Efficiency and CO_2 Emissions: Results for the Euro Area. *Ekonomika* 99: 6–25. [CrossRef]
Kumar, Sumit. 2022a. Critical assessment of green financing initiatives in emerging market: A review of india's green bond issuances. *Academy of Marketing Studies Journal* 26: 1–14.
Kumar, Sumit. 2022b. Effective Hedging Strategy for US Treasury Bond Portfolio Using Principal Component Analysis. *Academy of Accounting and Financial Studies Journal* 26: 1–11.
Kung, Chih-Chun, Xiaolong Lan, Yunxia Yang, Shan-Shan Kung, and Meng-Shiuh Chang. 2022. Effects of green bonds on Taiwan's bioenergy development. *Energy* 238: 121567. [CrossRef]
Lau, Peter, Angela Sze, Wilson Wan, and Alfred Wong. 2022. The Economics of the Greenium: How Much is the World Willing to Pay to Save the Earth? *Environmental and Resource Economics* 81: 379–408. [CrossRef]
Leal, José Eugenio. 2020. AHP-expres: A simplified version of the analytical hierarchy process method. *MethodsX* 7: 100748. [CrossRef] [PubMed]

Lebelle, Martin, Souad Lajili Jarjir, and Syrine Sassi. 2022. The effect of issuance documentation disclosure and readability on liquidity: Evidence from green bonds. *Global Finance Journal* 51: 100678. [CrossRef]
Liang, Yongtang. 2023. Mitigation Strategy For Lessening the Negative Impacts of Climate Change. *Transformations in Business & Economics* 22: 87–97.
Lin, Lin, and Yanrong Hong. 2022. Developing a Green Bonds Market:Lessons from China. *European Business Organization Law Review* 23: 143–85. [CrossRef]
Liu, Yadi, Abdullah A. Al-Atawi, Izaz Ahmad Khan, Neelam Gohar, and Qamar Zaman. 2023. Using the fuzzy analytical hierarchy process to prioritize the impact of visual communication based on artificial intelligence for long-term learning. *Soft Computing* 27: 157–68. [CrossRef]
Liu, Yan, Claudia M. Eckert, and Christopher Earl. 2020. A review of fuzzy AHP methods for decision-making with subjective judgements. *Expert Systems with Applications* 161: 113738. [CrossRef]
Löffler, Kristin Ulrike, Aleksandar Petreski, and Andreas Stephan. 2021. Drivers of green bond issuance and new evidence on the "greenium". *Eurasian Economic Review* 11: 1–24. [CrossRef]
Maino, Andrea Giulio. 2022. *Financing the Energy Transition: The Role, Opportunities and Challenges of Green Bonds*. Oxford: The Oxford Institute for Energy Studies.
Malik, Arsalan Haneef, Abu Hassan bin Md Isa, Mohamad bin Jais, Awais Ur Rehman, and Mubashir Ali Khan. 2022. Financial stability of Asian Nations: Governance quality and financial inclusion. *Borsa Istanbul Review* 22: 377–87. [CrossRef]
Mankata, Lawrence Martin, De-Graft Owusu-Manu, M. Reza Hosseini, and David John Edwards. 2022. Analysis of success-dependent factors for green bond financing of infrastructure projects in Ghana. *Journal of Sustainable Finance and Investment* 12: 832–48. [CrossRef]
Mathews, John A., and Sean Kidney. 2010. Climate bonds: Mobilizing private financing for carbon management. *Carbon Management* 1: 9–13. [CrossRef]
Migliorelli, Marco, and Philippe Dessertine. 2019. The Rise of Green Finance in Europe: Opportunities and Challenges for Issuers, Investors and Marketplaces. Available online: http://www.palgrave.com/gp/series/14621 (accessed on 18 March 2023).
Mohsin, Muhammad, Farhad Taghizadeh-Hesary, and Muhammad Shahbaz. 2022. Nexus between financial development and energy poverty in Latin America. *Energy Policy* 165: 112925. [CrossRef]
Naeem, Muhammad Abubakr, Mustafa Raza Rabbani, Sitara Karim, and Syed Mabruk Billah. 2023. Religion vs. ethics: Hedge and safe haven properties of Sukuk and green bonds for stock markets pre- and during COVID-19. *International Journal of Islamic and Middle Eastern Finance and Management* 16: 234–52. [CrossRef]
Naeem, Muhammad Abubakr, Thomas Conlon, and John Cotter. 2022. Green bonds and other assets: Evidence from extreme risk transmission. *Journal of Environmental Management* 305: 114358. [CrossRef] [PubMed]
Nguyen, Anh Huu, Thinh Gia Hoang, Duy Thanh Nguyen, Loan Quynh Thi Nguyen, and Duong Thuy Doan. 2023. The Development of Green Bond in Developing Countries: Insights from Southeast Asia Market Participants. *European Journal of Development Research* 35: 196–218. [CrossRef] [PubMed]
Nikolaj, Stella Suljić, Bojana Olgić Draženović, and Denis Buterin. 2022. Green Bonds—Sustainable Forms of Financing. In *Sustainable Business Management and Digital Transformation: Challenges and Opportunities in the Post-COVID Era*. Cham: Springer International Publishing. [CrossRef]
Ning, Yiyi, Jacob Cherian, Muhammad Safdar Sial, Susana Álvarez-Otero, Ubaldo Comite, and Malik Zia-Ud-Din. 2021. Green bond as a new determinant of sustainable green financing, energy efficiency investment, and economic growth: A global perspective. *Environmental Science and Pollution Research*. [CrossRef] [PubMed]
Otek Ntsama, Ursule Yvanna, Chen Yan, Alireza Nasiri, and Abdel Hamid Mbouombouo Mboungam. 2021. Green bonds issuance: Insights in low- and middle-income countries. *International Journal of Corporate Social Responsibility* 6: 1–9. [CrossRef]
Ozili, Peterson K. 2022. Green finance research around the world: A review of literature. *International Journal of Green Economics* 16: 56–75. [CrossRef]
Palit, Tanmoy, A. B. M. Mainul Bari, and Chitra Lekha Karmaker. 2022. An integrated Principal Component Analysis and Interpretive Structural Modeling approach for electric vehicle adoption decisions in sustainable transportation systems. *Decision Analytics Journal* 4: 100119. [CrossRef]
Petroutsatou, Kleopatra, Ilias Ladopoulos, and Konstantina Tsakelidou. 2022. Scientometric Analysis and AHP for Hierarchizing Criteria Affecting Construction Equipment Operators' Performance. *Sustainability* 14: 6836. [CrossRef]
Pineiro-Chousa, Juan, M. Ángeles López-Cabarcos, Jérôme Caby, and Aleksandar Šević. 2021. The influence of investor sentiment on the green bond market. *Technological Forecasting and Social Change* 162: 120351. [CrossRef]
Puaschunder, Julia M. 2023. Governance of Climate Justice: Taxation Transfers and Green Bonds. In *SDGs in the Americas and Caribbean Region. Implementing the UN Sustainable Development Goals—Regional Perspectives*. Cham and New York: Springer. [CrossRef]
Saaty, Thomas L., and Mujgan Sağır Özdemir. 2015. How Many Judges Should There Be in a Group? *Annals of Data Science* 1: 359–68. [CrossRef]
Sachs, Jeffrey, Wing Thye Woo, Naoyuki Yoshino, and Farhad Taghizadeh-Hesary, eds. 2019. Handbook of Green Finance. Energy Security and Sustainable Development. In *Handbook of Green Finance*. Singapore: Springer. [CrossRef]
Sevinç, Ali, Şeyda Gür, and Tamer Eren. 2018. Analysis of the Difficulties of SMEs in Industry 4.0 Applications by Analytical Hierarchy Process and Analytical Network Process. *Processes* 6: 264. [CrossRef]

Sinha, Avik, Shekhar Mishra, Arshian Sharif, and Larisa Yarovaya. 2021. Does green financing help to improve environmental and social responsibility? Designing SDG framework through advanced quantile modelling. *Journal of Environmental Management* 292: 112751. [CrossRef] [PubMed]

Siracusa, Vittorio. 2021. Green Bonds: The Sovereign Issuer's Perspective. Sustainable Finance and Investments: Experiences and Perspectives. Available online: https://mib.edu/en/newsroom/mib-lens-live-web-management-series (accessed on 18 March 2023).

Streimikiene, Dalia, Asta Mikalauskiene, and Greta Burbaite. 2023. The Role of Sustainable Finance in Achieving Sustainable Development Goals. *Economics and Sociology* 16: 256–83.

Štreimikienė, Dalia, Asta Mikalauskienė, and Ugnė Macijauskaitė-Daunaravičienė. 2022. Role of information management in implementing the Green Deal in the EU and the US. *Journal of International Studies* 15: 9–27. [CrossRef]

Sun, Licheng, Sui Fang, Sajid Iqbal, and Ahmad Raza Bilal. 2022a. Financial stability role on climate risks, and climate change mitigation: Implications for green economic recovery. *Environmental Science and Pollution Research*. [CrossRef]

Sun, Lirong, Kaili Wang, Lini Xu, Chonghui Zhang, and Tomas Balezentis. 2022b. A time-varying distance based interval-valued functional principal component analysis method—A case study of consumer price index. *Information Sciences* 589: 94–116. [CrossRef]

Teti, Emanuele, Icaro Baraglia, Maurizio Dallocchio, and Giovanna Mariani. 2022. The green bonds: Empirical evidence and implications for sustainability. *Journal of Cleaner Production* 366: 132784. [CrossRef]

Tiwari, Aviral Kumar, Emmanuel Joel Aikins Abakah, OlaOluwa Simon Yaya, and Kingsley Opoku Appiah. 2023. Tail risk dependence, co-movement and predictability between green bond and green stocks. *Applied Economics* 55: 201–22. [CrossRef]

Tomfort, André. 2022. Making Green Bonds Greener: Proposals to Increase the Efficiency of Green Bonds. *Journal of Applied Finance and Banking* 13: 39–59. [CrossRef]

Tona, Olgerta, Yixin Zhang, Aleksandre Asatiani, and Juho Lindman. 2023. Role of Data in the Building of Legitimacy for Green Bonds—Capturing, Contextualizing, and Communicating. Paper presented at 56th Hawaii International Conference on System Sciences, Maui, HI, USA, January 3–6; pp. 5400–9, ISBN 978-0-9981331-6-4.

Torvanger, Asbjørn, Maltais Aaron, and Iulia Marginean. 2021. Green bonds in Sweden and Norway: What are the success factors? *Journal of Cleaner Production* 324: 129177. [CrossRef]

Tripathy, Aneil, Lionel Mok, and Grégoire Lunven de Chanrond. 2020. A Multidisciplinary Literature Review of Academic Research on the Green Bond Market. *Journal of Environmental Investing* 10: 100–28.

UNEP. 2019. *Strengthening the Environmental Dimensions of the Sustainable Development Goals in Asia and the Pacific*. Kenya: United Nations Environment Programme.

Vafaei, Nazanin, Rita A. Ribeiro, and Luis M. Camarinha-Matos. 2016. Normalization Techniques for Multi-Criteria Decision Making: Analytical Hierarchy Process Case Study. In *Technological Innovation for Cyber-Physical Systems*. Cham: Springer, pp. 261–69. [CrossRef]

Verma, Rakesh Kumar, and Rohit Bansal. 2023. Stock Market Reaction on Green-Bond Issue: Evidence from Indian Green-Bond Issuers. *The Journal of the Business Perspective* 27: 264–72. [CrossRef]

Vojtek, Matej, and Jana Vojteková. 2019. Flood Susceptibility Mapping on a National Scale in Slovakia Using the Analytical Hierarchy Process. *Water* 11: 364. [CrossRef]

Wang, Chia-Nan, Ying-Fang Huang, I-Fang Cheng, and Van Thanh Nguyen. 2018. A Multi-Criteria Decision-Making (MCDM) Approach Using Hybrid SCOR Metrics, AHP, and TOPSIS for Supplier Evaluation and Selection in the Gas and Oil Industry. *Processes* 6: 252. [CrossRef]

Wang, Kai-Hua, Chi-Wei Su, Muhammad Umar, and Adelina Dumitrescu Peculea. 2023. Oil prices and the green bond market: Evidence from time-varying and quantile-varying aspects. *Borsa Istanbul Review* 23: 516–26. [CrossRef]

Wang, Yi. 2021. The Development and Usage of NPV and IRR and Their Comparison. *Advances in Economics, Business and Management Research* 203: 2044–48.

Yap, Jeremy Y. L., Chiung Ching Ho, and Choo-Yee Ting. 2017. Analytic Hierarchy Process (AHP) for business site selection. *AIP Conference Proceedings* 2016: 020151. [CrossRef]

Ye, Xiang, and Ehsan Rasoulinezhad. 2023. Assessment of impacts of green bonds on renewable energy utilization efficiency. *Renewable Energy* 22: 626–33. [CrossRef]

Yu, Dejian, Gang Kou, Zeshui Xu, and Shunshun Shi. 2021. Analysis of Collaboration Evolution in AHP. *International Journal of Information Technology and Decision Making* 20: 7–36. [CrossRef]

Zenno, Yoshihiro, and Kentaka Aruga. 2023. Investigating Factors Affecting Institutional Investors' Green Bond Investments: Cases for Beijing and Shenzhen. *Sustainability* 15: 4870. [CrossRef]

Zeqiraj, Veton, Kazi Sohag, and Ugur Soytas. 2020. Stock market development and low-carbon economy: The role of innovation and renewable energy. *Energy Economics* 91: 104908. [CrossRef]

Zhang, Linyun, Feiming Huang, Lu Lu, Xinwen Ni, and Sajid Iqbal. 2022. Energy financing for energy retrofit in COVID-19: Recommendations for green bond financing. *Environmental Science and Pollution Research* 29: 23105–16. [CrossRef] [PubMed]

Zhao, Linhai, Ka Yin Chau, Trung Kien Tran, Muhammad Sadiq, Nguyen Thi My Xuyen, and Thi Thu Hien Phan. 2022. Enhancing green economic recovery through green bonds financing and energy efficiency investments. *Economic Analysis and Policy* 76: 488–501. [CrossRef]

Zhou, Hongji, and Guoyin Xu. 2022. Research on the impact of green finance on China's regional ecological development based on system GMW model. *Resources Policy* 75: 102454. [CrossRef]