economies

MDPI

Article

Connectedness between Sustainable Investment Indexes: The QVAR Approach

Nini Johana Marín-Rodríguez [1,*], Juan David Gonzalez-Ruiz [2] and Sergio Botero [3]

[1] Grupo de Investigación en Ingeniería Financiera GINIF, Programa de Ingeniería Financiera, Facultad de Ingenierías, Universidad de Medellín, Medellin 050026, Colombia
[2] Grupo de Investigación en Finanzas y Sostenibilidad, Departamento de Economía, Facultad de Ciencias Humanas y Económicas, Universidad Nacional de Colombia—Sede Medellín, Medellin 050034, Colombia; jdgonza3@unal.edu.co
[3] Departamento de Ingeniería de la Organización, Facultad de Minas, Universidad Nacional de Colombia—Sede Medellín, Medellin 050034, Colombia; sbotero@unal.edu.co
* Correspondence: njmarin@udemedellin.edu.co

Abstract: We studied the relationship between sustainable investment indexes and examine whether this relationship varies in bullish, bearish, and stable financial markets. To understand this issue more deeply, we analyzed the connectedness between three indexes—the Sustainable Impact investments, Paris-aligned stocks, and green bonds indexes—using the daily closing prices from 1 June 2017 to 15 April 2024, encompassing 1793 observations. We used a quantile vector autoregressive (QVAR) model to understand the dynamic relationship among the considered indices. The findings indicate that sustainable investments are strongly interconnected in both high and low quantiles, but this connection weakens significantly during periods of market stability. The Sustainable Impact investments and Paris-aligned stocks indexes are net transmitters of impacts to other sustainable alternatives, while the green bonds index is a net receiver. We also observed an increase in interconnectedness across all quantiles during the pandemic, the Russia–Ukraine military conflict, and changes in the European Union and the United States' monetary policies.

Keywords: SDGs; sustainable investment; green bonds; climate finance; QVAR

Citation: Marín-Rodríguez, Nini Johana, Juan David Gonzalez-Ruiz, and Sergio Botero. 2024. Connectedness between Sustainable Investment Indexes: The QVAR Approach. *Economies* 12: 170. https://doi.org/10.3390/economies12070170

Academic Editors: Tiago Lopes Afonso and Nuno Carlos Leitão

Received: 31 May 2024
Revised: 27 June 2024
Accepted: 1 July 2024
Published: 2 July 2024

1. Introduction

The agenda for sustainable development adopted by the United Nations (UN) member states in 2015 identified 17 sustainable development goals (SDGs) for 2030 regarding prosperity for people and a sustainable planet. Achieving the SDGs requires a vast amount of funding efforts (United Nations 2018), which have sometimes been threatened and dispersed across different goals, due to events such as the pandemic, the growing pace of climate change, and military conflicts such as that between Russia and Ukraine. Additionally, countries face unequal challenges regarding SDGs, making global investment in SDGs uncertain and generally tilting them to sectors such as renewable energies. Therefore, since there are synergies and tradeoffs between investments in SDGs and investments with a specific sustainability orientation, e.g., climate change (Nerini et al. 2019; Bisaga et al. 2021; He et al. 2022), the outcomes of those investments may reasonably differ.

Our study finds that returns on different sustainable investment indexes are connected, and that this connection might vary under market circumstances such as bull, bear, and calm financial markets. Sustainability-conscious investors are particularly concerned with those issues, as it would facilitate decision-making regarding portfolio investments and risk management by considering only the financial instruments aligned with their sustainability stance. Likewise, the transmission of shocks between sustainable investments under different market conditions provides valuable information for policymakers regarding

supporting SDG funding when the private sector is reluctant to do so due to the return and risk considerations of sustainable assets.

Investigating the connectedness of different sustainable investments is crucial as it offers both theoretical and practical implications. From a theoretical perspective, understanding the interconnected behavior of various sustainable investments can elucidate the dynamics and spillover effects within the sustainable finance sector, enriching the literature on financial market interdependencies. Practically, this knowledge aids investors in optimizing their portfolios to enhance returns while adhering to sustainability goals, and assists policymakers in designing frameworks to support and stabilize sustainable investments, especially in times of economic uncertainty, where coordinated policies can help stabilize sustainable investment flows and ensure continued progress towards achieving the SDGs.

Related literature includes studies that examine the private funding of sustainable goals (e.g., Bei and Wang 2023; Taghizadeh-Hesary and Yoshino 2019; Yoshino et al. 2021) and the de-risking of sustainable investments (e.g., Heine et al. 2019; Reboredo et al. 2022). Our analysis is also related to the socially responsible investment literature that considers spillovers between sustainable investments across countries (e.g., Iqbal et al. 2022; Umar et al. 2020), and also the literature on environmental, social, and governance (ESG) standards and climate mitigation investment outcomes, that examines the relative performance of sustainable vs. traditional assets when investors include sustainability concerns in their investment decisions (see, e.g., Hawn et al. 2018; Muñoz 2021; Pástor et al. 2022; Reboredo and Otero 2021). By examining the relationship between different sustainable financial instruments, including stock and bond securities, we add to the literature by providing a more comprehensive view of how conditional dependence between sustainable investment returns differ according to market conditions, and on how diversification strategies could be adapted depending on the state of the financial markets.

Sustainable investing is a broader term that includes various approaches to integrating ESG considerations into investment decisions, aiming to balance financial returns and societal benefits (Çatak 2024). There are important characteristics between three key values-based investment or sustainable investing approaches: SRI (socially responsible investing), ESG investing, and impact investing. With its historical roots in screening investments to align with personal values, SRI excludes companies conflicting with ethical principles (Gillan et al. 2021). ESG investing focuses on companies actively managing societal and environmental impact, while impact investing directly connects capital to values-based priorities, striving to quantify and generate positive societal outcomes (BinMahfouz and Kabir Hassan 2013). Also, impact investing primarily involves private funds, offering transparency into capital allocation for specific causes but posing accessibility challenges compared to publicly traded options (Agrawal and Hockerts 2021). In this way, investors and managers need to understand these approaches to make informed choices in the ever-evolving landscape of values-based investing.

We specifically consider three kinds of returns on sustainable investments. First, we consider returns on investments in companies involved in at least one of the SDGs defined by the UN and included in the MSCI All Country World Index (MSCI ACWI) Sustainable Impact Index. Second, regarding sustainable investments, we consider returns on investments in companies included in the MSCI World Natural Capital Paris-Aligned Index (Paris-aligned stock index), which comply with the Paris-aligned benchmarks, minimize their adverse impact on natural resources, and positively contribute to the environment. Finally, we consider the outcome of investments in green bonds, which are fixed-income financial instruments that raise funds for pro-environmental projects. Given that the connection between returns on those three sustainable investment types and their response to natural catastrophes, social and military conflicts, financial market stability, and green technological innovations may differ due to their nature (e.g., stocks vs. bonds), this study examines their interdependence using the quantile vector autoregressive (QVAR) model. The QVAR model addresses the conditional quantile dependence between variables while allowing quantile heterogeneity in the impact of shocks. Thus, different types of

connectedness emerge depending on boom-and-bust moments in the financial markets. Furthermore, using the generalized forecast error variance decomposition, it is possible to build a quantile-based connectedness network (Ando et al. 2022) that yields information on whether and how each sustainable investment class acts as a transmitter or recipient of return spillover shocks, considering bull, bear, and calm moments in financial markets.

This study contributes to the literature from both practical and academic perspectives in three significant ways. Firstly, we employ a quantile vector autoregressive (QVAR) model to examine sustainable investment indexes, revealing their increased interconnectedness during crucial periods influenced by geopolitical events and monetary policy changes. This information aids investors and policymakers in better understanding sustainable investing dynamics. Secondly, we highlight the role of the Sustainable Impact Index as a leading transmitter of effects among sustainability indexes, underscoring its growing importance and potential impact on sustainable investment decisions, thus providing valuable guidance for investors and academics interested in socially responsible investing. Thirdly, our research integrates empirical methodologies into exploring sustainable investment dynamics, bridging the gap between theoretical frameworks and real-world applications (Talan and Sharma 2019; Camilleri 2021). Through this integration, we aim to advance the theoretical understanding of sustainable investment and provide actionable insights for scholars and practitioners in the field. Thus, our findings help to attain sustainable development goals by promoting informed investment decisions, guiding policymakers, and supporting efficient funding allocation towards sustainable projects.

The study is structured as follows: Section 2 describes data and outlines the QVAR model. In Section 3, we present and discuss empirical evidence. In Section 4, we summarize our results and discussion. Finally, Section 5 offers some conclude remarks.

2. Context of the Analysis and Literature Review

2.1. Context of the Analysis

Understanding the interchangeable use of terms like sustainable investing, SRI, ESG investing, and impact investing is crucial for investors and policymakers. By recognizing their distinctions and commonalities, stakeholders can develop more coherent and effective investment strategies that promote both financial returns and positive societal outcomes. The study of Çatak (2024) provides a foundational analysis that can guide future research and practice in this dynamic field (Figure 1).

Çatak (2024) explores the interchangeability of terms like "sustainable investing", "socially responsible investing (SRI)", "environmental, social, and governance investing" (ESG), and "impact investing" in the literature. It aims to enhance the understanding of these concepts by analyzing previous research and elucidating their distinctions and commonalities. It posits sustainable investing as an overarching term encompassing these approaches. ESG investing involves evaluating a company's ESG practices alongside financial metrics, primarily aiming for financial returns. SRI entails investment decisions guided by moral criteria. Impact investing allows investors to support ventures generating social value. As the field evolves, there is a growing recognition of the need for standardized definitions and frameworks to enhance clarity and comparability.

Sustainable investing is a broad concept that encompasses various strategies, such as SRI, ESG investing, and impact investing (Figure 1). Sustainable investing primarily aims to generate long-term financial returns while promoting environmental stewardship, social responsibility, and sound governance practices. This broad approach integrates ESG criteria into the investment process, recognizing that addressing these factors can contribute to the long-term value creation of a portfolio. While it encompasses several specific strategies, sustainable investing's overarching goal is to consider the broader impacts of investment decisions on society and the environment.

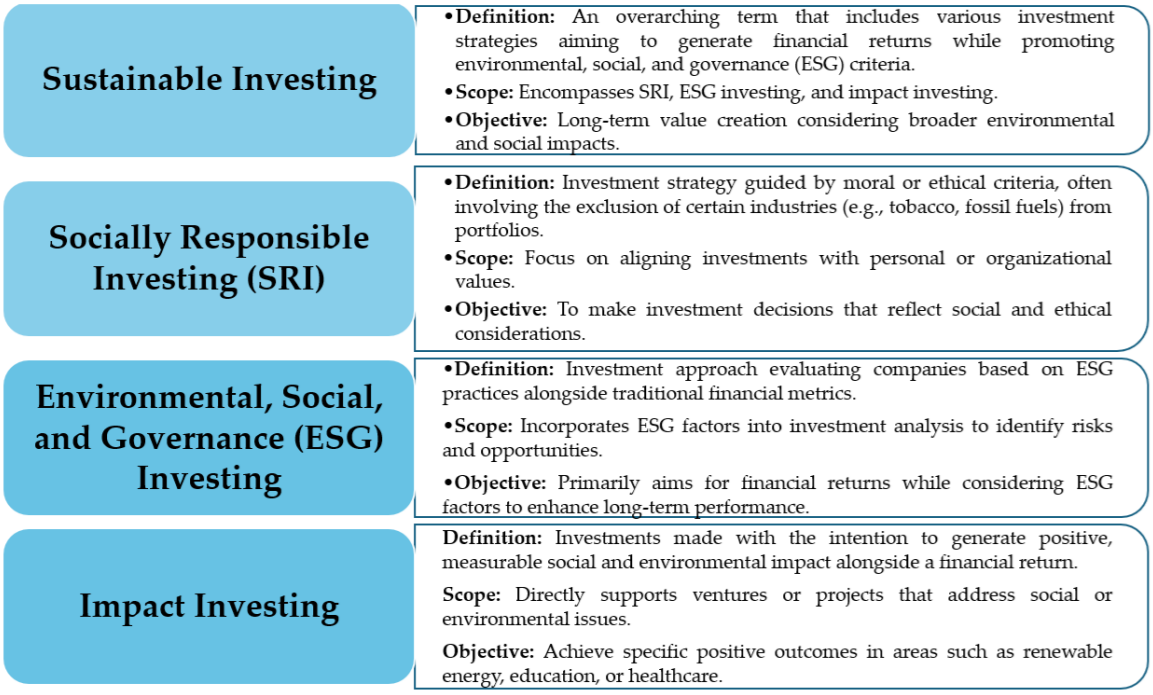

Figure 1. Scheme for interchangeable use of sustainable investing terms. Source: Authors, based on Çatak (2024).

Each strategy within sustainable investing has its unique focus and methodology (Figure 1). SRI is guided by moral or ethical criteria, often excluding specific industries, such as tobacco or fossil fuels, from investment portfolios. This strategy aims to align investments with personal or organizational values. ESG investing, on the other hand, involves evaluating companies based on their ESG practices alongside traditional financial metrics, primarily aiming for financial returns while considering ESG factors to enhance long-term performance. Impact investing is more targeted, with investments made specifically to generate positive, measurable social and environmental impacts alongside financial returns. It directly supports ventures or projects that address critical social or environmental issues, such as renewable energy or education. While all these strategies fall under the sustainable investing umbrella, their specific objectives and approaches differ, reflecting a spectrum of priorities from ethical alignment to targeted impact.

Recognizing the differences among terms such as sustainable investing, SRI, ESG investing, and impact investing is crucial for several reasons. Each term represents distinct objectives and methodologies, leading to varied implications for investment strategies and outcomes. For instance, while ESG investing focuses on integrating ESG factors into financial analysis to enhance risk-adjusted returns, SRI emphasizes alignment with ethical values, often employing exclusionary screens. Impact investing, on the other hand, seeks to generate specific social or environmental benefits alongside financial returns. By clearly distinguishing these terms, investors can make more informed decisions that align with their financial goals and ethical priorities, ultimately contributing to more targeted and effective investment portfolios.

The concepts underlying these investment strategies often exhibit co-movements over time, driven by evolving market trends, regulatory developments, and societal expectations. For example, the increasing awareness and urgency of addressing climate change have propelled the integration of ESG factors across various investment strategies, including SRI and impact investing. As regulatory frameworks and corporate reporting standards advance, these approaches become more interconnected, promoting a cohesive shift toward sustainability in financial markets. Moreover, investor demand for transparency and accountability fosters the convergence of these terms, as stakeholders seek comprehensive

approaches that encompass financial performance and broader social and environmental impacts. Understanding these co-movements helps investors and policymakers anticipate and navigate the dynamic landscape of sustainable finance, fostering a more resilient and inclusive economic system.

2.2. Literature Review

We conducted a literature review by carefully selecting articles from the Scopus and Web of Science (WoS) databases in April 2024. Our search queries included terms such as [sri], [esg], and ["Impact Invest*"] or ["sustainable invest*"] to identify articles related to sustainable investing, encompassing topics like SRI, ESG investing, and impact investing. Initially, we identified 44 articles in Scopus and 33 in Web of Science. After removing 22 duplicate articles, we were left with 55 unique and relevant articles for further analysis. This search approach was adopted to ensure a comprehensive selection of literature concerning the intersection of SRI, ESG investing, and impact investing, thereby laying the foundation for a systematic review of pertinent scholarly contributions.

2.2.1. Keyword Analysis

The filtered articles were then analyzed using the online text analytic software Voyant Tools version 2.4 (Sinclair and Rockwell 2020), followed by a manual review of the abstract, introduction, and conclusion sections to select the most relevant articles for our study.

In scrutinizing the words identified in abstracts and author keywords gathered from the literature review, several metrics unveil valuable insights into the corpus. The vocabulary density, calculated at 0.181, suggests a moderate level of lexical diversity, indicating the ratio of unique words to the total number of words in the text. Meanwhile, the readability index, computed at 17.503, hints at the text's comprehensibility, indicating a moderate level of complexity suitable for individuals with some college education. The average number of words per sentence, averaging at 27.7, sheds light on the text's syntactic complexity, suggesting the presence of longer, more intricate sentence structures. Delving into the frequency of keywords, prominent terms such as "SRI" (189 occurrences), "ESG" (188 occurrences), "sustainable" (184 occurrences), "investment" (175 occurrences), responsible (123 occurrences), and "impact" (93 occurrences) emerge as central themes within the corpus, underlining the prevalent focus on SRI and ESG considerations throughout the analyzed literature (Figure 2).

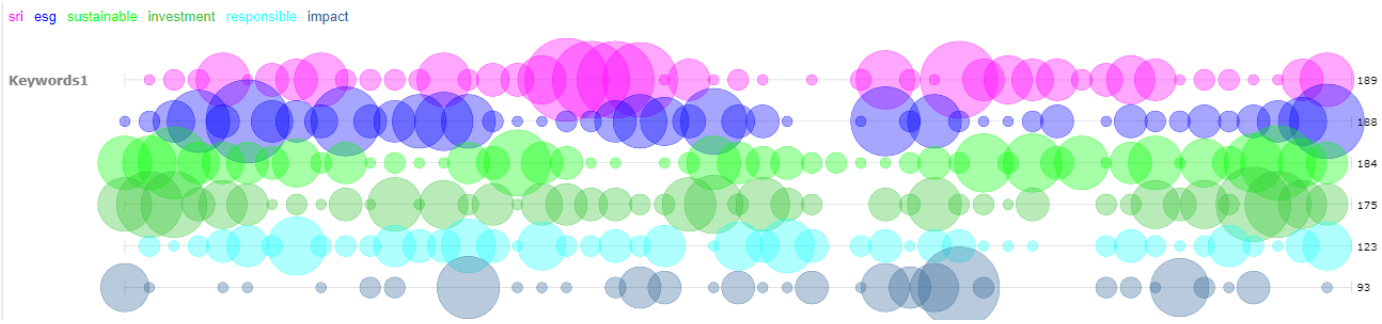

Figure 2. Bubble lines from the most frequent words in abstracts and author keywords on the study of interchangeable use of sustainable investing terms. Notes: Each chosen word is depicted as a bubble, where the size of the bubble reflects the word's frequency within the corresponding text segment. A larger bubble indicates that the word appears more often. Source: analysis conducted using Voyant tools and data from the Scopus WoS databases.

Additionally, the results of relative frequency and trend analysis for the most frequent words in abstracts and author keywords related to the interchangeable use of sustainable investing terms are presented in Figure 3. In Voyant Tools, the "Trends" visualization depicts the frequencies of terms across studies identified using our search equation in the Scopus and Web of Science databases. The identified words "SRI", "ESG", "sustainable",

"investment", "responsible", and "impact" generally exhibit an increasing trend over time, with the exception of "impact". This trend highlights these topics' growing importance and relevance in contemporary discourse.

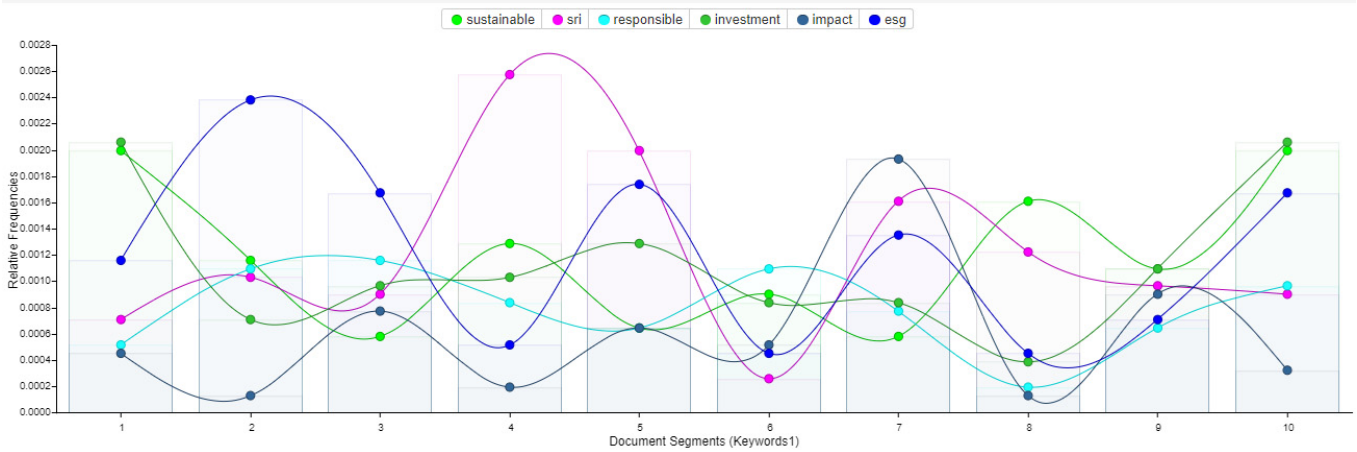

Figure 3. Relative frequencies and trends from the most frequent words in abstracts and author keywords on the study of the interchangeable use of sustainable investing terms. Notes: Each series in the graph is colored to represent a specific word, and at the top of the graph, a legend indicates which colors correspond to which words. Source: analysis conducted using Voyant tools and data from the Scopus WoS databases.

2.2.2. Trends Analysis

After the initial search, all identified research papers were downloaded and indexed in the Mendeley reference manager for further examination. The subsequent analysis was performed using VOSviewer version 1.6.19 (van Eck and Waltman 2017) and a Tree of Science application that presents a clustering analysis of the three main subtopics (Robledo et al. 2022). Structural patterns and research trends were then identified using co-occurrence author keywords diagrams. This approach allowed for the detection and examination of three distinct research trends within the scientific literature, as in the study conducted by Marín-Rodríguez et al. (2022). Figure 4 illustrates these findings: the top section displays key studies on the relationships among SRI, ESG investing, and impact investing, while the bottom section outlines the three identified research trends.

The first trend derived from the provided information is the extensive exploration of SRI and corporate sustainability by authors such as Aras and Crowther (2009), Auer (2016), Becchetti et al. (2015), Bugg-Levine and Emerson (2011), Camilleri (2020, 2021), and Entine (2003). These studies cover a wide range of topics, including the evaluation and review of the SRI market, the impact of SRI policies on European stock portfolio value, comparative analyses of SRI in different regions, and the performance comparison of socially responsible and conventional investment funds, as well as the role of institutional investors in shareholder activism. This trend reflects a growing interest in understanding the relationship between ethical investment practices, corporate behavior, and financial performance, highlighting the significance of SRI in shaping investment decisions and corporate strategies.

The second trend is focused on SRI and ESG considerations in financial markets. Researchers such as ElBannan (2024), Geczy et al. (2021), and Sabbaghi (2011) explore the resilience of ESG funds during market downturns, the investment behavior in socially responsible mutual funds, and the performance comparison of green exchange-traded funds with conventional benchmarks like the S&P 500, respectively. This trend reflects a growing interest among investors and researchers in understanding the relationship between ethical considerations and financial performance, and the potential for sustainable investment strategies to contribute to financial market stability and sustainability.

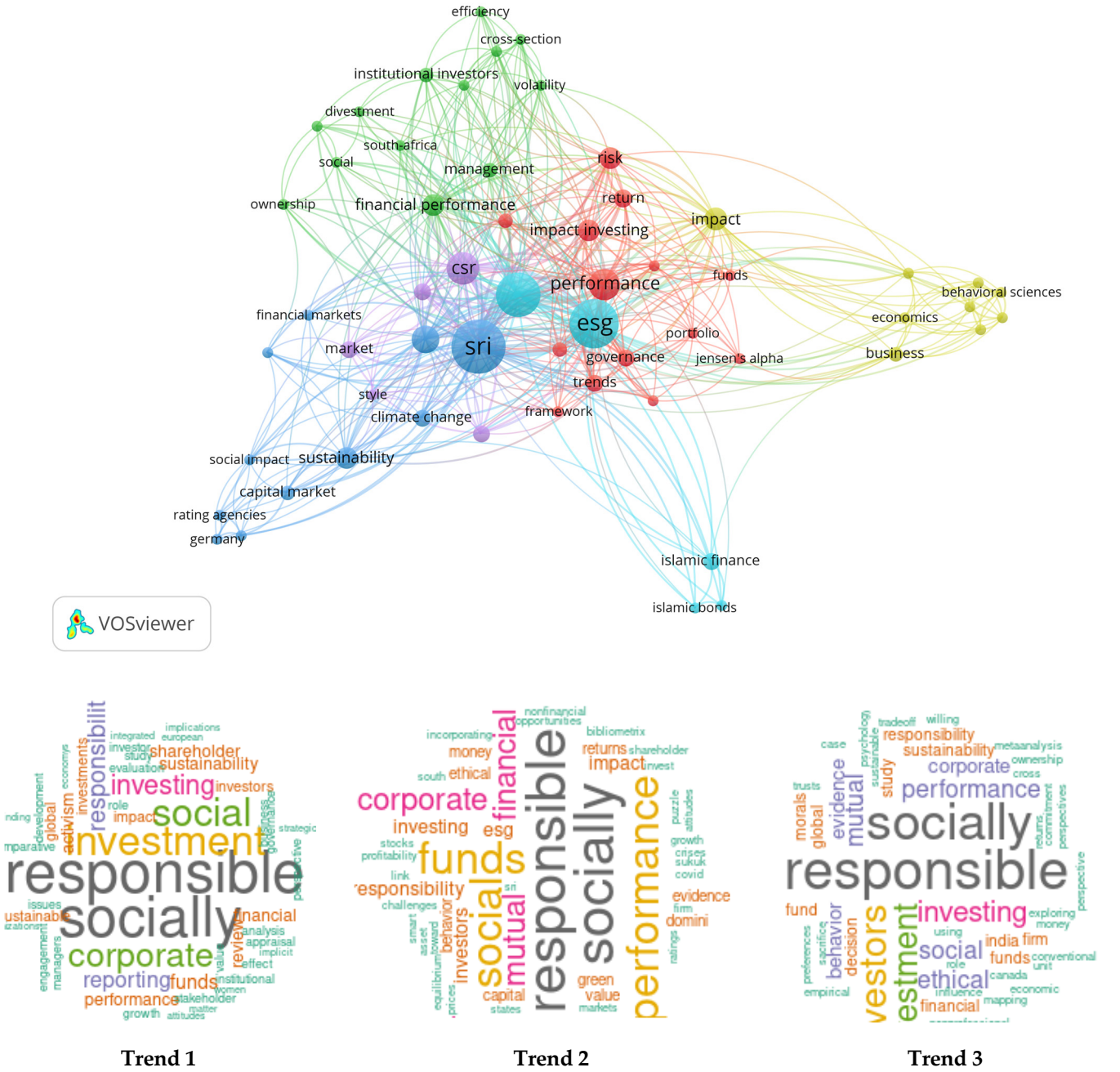

Figure 4. Relationships among the most significant studies and research trends concerning SRI, ESG investing, and impact investing. Source: analysis conducted using VOSviewer and Tree of Science tools, and data from the Scopus and WoS databases.

Finally, the third trend explores the relationship between SRI behavior and financial performance, as evidenced by studies conducted by Jonwall et al. 2023; Bodhanwala and Bodhanwala 2018, 2019; and Gil-Bazo et al. 2010. These studies investigate various aspects of SRI behavior, including individual investor preferences, the influence of sustainability information on investment decision-making, and the performance of socially responsible mutual funds compared to conventional funds. Additionally, there is a growing interest in understanding the determinants of SRI decisions across different countries and investor segments, as evidenced by research conducted by Chatzitheodorou et al. (2019) and McLachlan and Gardner (2004). This trend underscores the importance of considering ethical and social factors in investment decisions and highlights the evolving landscape of SRI research and practice.

After discerning the prevailing trends in the evolution of literature concerning sustainable investments, our next step involves scrutinizing the gaps exposed by preceding literature review research. This scrutiny aims to identify how our study addresses a gap delineated by prior research.

2.2.3. Further Research Identified from Previous Literature

The literature reviews by Beisenbina et al. (2023), Camilleri (2021), Daugaard et al. (2024), Delle Foglie and Keshminder (2022), Kapil and Rawal (2023), Singhania et al. (2024), and Talan and Sharma (2019) collectively reveal several trends and research gaps in the field of sustainable investment, albeit with differing emphases and methodologies.

Singhania et al. (2024)'s review highlights emerging themes such as SDG financing and the governance-related determinants of sustainable investments, providing a comprehensive foundation for future research. In contrast, Beisenbina et al. (2023)'s study traces the evolution of SRI strategies and identifies a shift towards more nuanced approaches, like ESG integration and impact investing. These differing perspectives suggest a need for further exploration into the drivers and implications of evolving sustainable investment strategies.

Talan and Sharma (2019)'s systematic review identifies gaps in the literature and proposes a holistic research agenda to develop sustainable investment as an applied field. Meanwhile, Camilleri (2021)'s historic overview emphasizes the proliferation of SRI products and the increasing involvement of stakeholders, highlighting the need for research into the opportunities and challenges facing SRI stakeholders. These contrasting viewpoints underscore the complexity of the sustainable investment landscape and the importance of addressing both theoretical and practical considerations in future research.

Kapil and Rawal (2023)'s review focuses on ESG investing, identifying significant research themes such as investor behavior and motivations, portfolio screening, and ESG performance. Additionally, Daugaard et al. (2024)'s study examines the utilization of corporate sustainability information in SRI, highlighting the need for research on data utilization and analysis methods. These complementary perspectives underscore the interdisciplinary nature of sustainable investment research and the importance of integrating insights from diverse fields, such as finance, accounting, and sustainability.

Delle Foglie and Keshminder (2022)'s review of SRI Sukuk highlights challenges such as the lack of standardization and liquidity, suggesting avenues for future research in Islamic investing and sustainable finance. This perspective complements the broader discussions on sustainable investment strategies and underscores the need for tailored approaches to address the unique challenges and opportunities in different financial contexts.

Additionally, according to Athari (2024), further research should focus on investigating the interplay between combined and individual sustainability (ESG) practices and banking sector stability in the GCC from 2000 to 2022. The findings underscore the critical roles of banking sector-specific factors and country-level dynamics in shaping stability outcomes. Notably, the study reveals a nuanced, non-linear relationship—displayed as an inverted U-shaped curve—between ESG practices and stability. This suggests that while sustainability initiatives can bolster stability, excessive investments in environmental (ENV), social (SOC), and governance (GOV) domains could potentially undermine it. Policymakers and bank executives are encouraged to adopt a balanced approach that aligns ESG investments with national SDGs to mitigate risks, such as profitability challenges and heightened instability. Moreover, future research should explore optimal resource allocation strategies within banks to reduce operational costs, enhance credit monitoring practices, and effectively manage non-performing loans (NPLs). This expanded investigation should also encompass other countries and consider external factors, such as the impact of global events like the COVID-19 pandemic on the identified relationships.

Lastly, the studies by Chuliá et al. (2017); Yaya et al. (2024); and Cocca et al. (2024) significantly contribute to the understanding of interconnectedness in financial markets, which is pertinent to our investigation on the connectedness between sustainable invest-

ment indexes using the QVAR approach. Chuliá et al. (2017)'s use of multivariate quantile models across the Latin American and developed markets reveals varying degrees of tail-codependence in response to shocks, suggesting potential diversification strategies across regions following significant market events. Yaya et al. (2024)'s analysis of African stock markets via quantile dynamic connectedness underscores the importance of understanding market interdependencies under different market phases, particularly highlighting South Africa's dominant role in transmitting shocks regionally. This complements our focus on how sustainable investment indexes respond to market conditions and further underscores the relevance of considering diverse market environments. Finally, Cocca et al. (2024)'s study on clean energy indices using a DCC-GARCH-based approach illuminates the dynamic nature of return propagation and identifies the NASDAQ OMX Green Economy Index as a key transmitter of shocks, offering insights into portfolio management strategies that are highly relevant to sustainable investments. Collectively, these studies provide a robust foundation for exploring the interconnections among sustainable investment indexes and advancing our understanding of their implications in global financial markets.

In summary, while the existing literature reviews provide valuable insights into sustainable investment, they highlight the critical need for empirical studies and co-movement analyses of the indices related to sustainable investment. This research specifically addresses this gap by investigating the empirical interconnectedness of various sustainable investment indexes, such as those linked to the SDGs, the Paris-aligned index, and green bonds. We hypothesize that the returns on these sustainable investment indexes exhibit significant interconnectedness, which varies under different market conditions, including bull, bear, and calm financial markets. By employing the quantile vector autoregressive (QVAR) model, this study delves into the conditional dependence and quantile heterogeneity of shocks on sustainable investment returns. This empirical approach fills existing knowledge gaps and provides practical insights for investors, policymakers, and other stakeholders navigating the complex landscape of sustainable finance. By synthesizing theoretical insights with empirical evidence, our research aims to offer a more holistic understanding of sustainable investment and its broader implications.

3. Data and Methods

3.1. Data

The dataset involves daily closing prices in US dollars from 1 June 2017 to 15 April 2024, encompassing 1793 observations. This study employs three indexes encapsulating SRI, ESG, and impact investing dimensions, as illustrated in Table 1. All variables were extracted from Bloomberg.

Table 1. List of variables.

Variable	Ticker	Returns	Name
Sustainable Impact Index	NU751091 Index	RNU751091	MSCI ACWI Sustainable Impact Index
Paris-aligned stock Index	MXCXBLRV Index	RMXCXBLRV	MSCI World Natural Capital Paris-Aligned Equity Select Index
Global Green Bond Index	I31572 Index	RI31572	MSCI Global Green Bond Index

Source: Authors' own research using Bloomberg.

Then, the selected indexes reflect different aspects of sustainable and socially responsible investing. The ACWI Sustainable Impact Index (RNU751091) focuses on sustainable bonds, the Paris-aligned index (RMXCXBLRV) emphasizes stocks that meet the EU Paris-aligned benchmarks, and the Global Green Bond Index | (RI31572) combines various ESG factors for Eurozone corporations. Investors interested in socially responsible investing may use these indexes to evaluate opportunities that align with their investment portfolios.

The MSCI ACWI Sustainable Impact Index comprises listed companies that generate at least 50% of their income through one or more of the UN SDGs and maintain minimum ESG standards. Such companies focus on pollution prevention, sanitary and nutritious products, sustainable water, green building, affordable housing, education, the treatment of major diseases, alternative energies, energy efficiency, and credit for small and medium firms. Therefore, the performance of the MSCI ACWI Sustainable Impact Index reflects the outcome of impact-oriented investments in the global equity markets that are specifically related to SDG sectors and projects.

Additionally, the Paris-aligned stock index, composed of companies that (a) comply with the EU Paris-aligned benchmarks and annually reduce greenhouse gas emissions by 7%, (b) minimize their exposure to indicators associated with adverse impact on natural resources, and (c) positively contribute to the environment through their products, services, or management of natural-capital related risks. The Paris-aligned stock index provides information to sustainability-oriented investors who wish to reduce their exposure to physical and transition risks from climate change, focusing on investment opportunities from the transition to a low-carbon economy.

Finally, the MSCI Global Green Bond Index comprises fixed-income green bonds issued by corporations, the Treasury, and government-related entities to promote climate or sustainability objectives. Those green bonds are: (a) rated and categorized as green by MSCI ESG Research according to rules that are consistent with the green bond principles; (b) have a one-year minimum time to maturity; and (c) are used for investment in alternative energies, energy efficiency, pollution prevention and control, sustainable water supplies, green building, and climate adaption. The MSCI Global Green Bond Index performance reflects the outcome of investments in fixed-income securities, issued with the aim of funding projects with sustainable and environmental benefits.

We use the returns of the selected indexes to analyze connectedness. Table 2 provides the descriptive statistics of daily returns for the indexes analyzed. These returns exhibit asymmetry and negative skewness. The prevalence of negative values suggests leptokurtic and heavy-tailed characteristics. The Jarque–Bera (J-B) test statistics confirm that all return distributions deviate from normality with significant *p*-values. The Ljung–Box Q(20) and Q2(20) statistics for serial correlation and heteroscedasticity are significant, indicating the presence of these effects in the return series. The augmented Dickey–Fuller (ADF) (Dickey and Fuller 1979) test results confirm the stationarity of all series.

Table 2. Summary statistics for sustainable investment returns.

	Mean	Std. Dev.	Min	Max	Skew	Kurt	J-B	Q(20)	Q2(20)	ADF
Sustainable Impact Investments index	0.0002	0.0086	−0.0892	0.0525	−0.79	13.03	7693.3 [0.00]	107 [0.00]	1012.4 [0.00]	−12.52 [0.00]
Paris-aligned stocks index	0.0004	0.0102	−0.1015	0.0821	−1	19.22	19,938.4 [0.00]	190.18 [0.00]	2048.3 [0.00]	−12.44 [0.00]
Green bonds index	0	0.0046	−0.0303	0.0263	−0.1	7.49	1511.5 [0.00]	54.76 [0.00]	786.31 [0.00]	−36.54 [0.00]
Correlation matrix										
Sustainable Impact Index investments	1									
Paris-aligned stocks index	0.82	1								
Green bonds index	0.39	0.27	1							

Notes. This table presents descriptive statistics for logarithmic price changes computed for the MSCI ACWI Sustainable Impact Index, the MSCI World Natural Capital Paris-Aligned Equity Index, and the MSCI Global Green Bond Index. Daily data span from 1 June 2017 to 15 April 2024. Q(20), Q2(20), and ADF denote the Ljung–Box statistic for serial correlation and heteroscedasticity, respectively, in returns computed with 20 lags. The ADF (augmented Dickey–Fuller) unit root test confirms stationary returns. All the *p*-values are reported in squared brackets. The correlation matrix reports the Pearson correlation for the series indicated in columns and rows. Source: Authors' own research using data from Bloomberg.

The correlation matrix reveals that indexes of Sustainable Impact investments and Paris-aligned indexes are strongly correlated (0.82), whereas the green bonds index shows moderate correlation with both the Sustainable Impact investments index (0.39) and the Paris-aligned index (0.27). These findings offer valuable insights into the various characteristics of sustainable investment returns and their interrelationships.

Figure 5 shows that both the Sustainable Impact investments and the Paris-aligned indexes closely co-move, and green bonds weakly co-moves with Sustainable Impact investments while, as expected, displaying lower variability. The indexes display a certain degree of synchronization, particularly during major economic events. This suggests that external macroeconomic factors influence all three indices, albeit to varying extents.

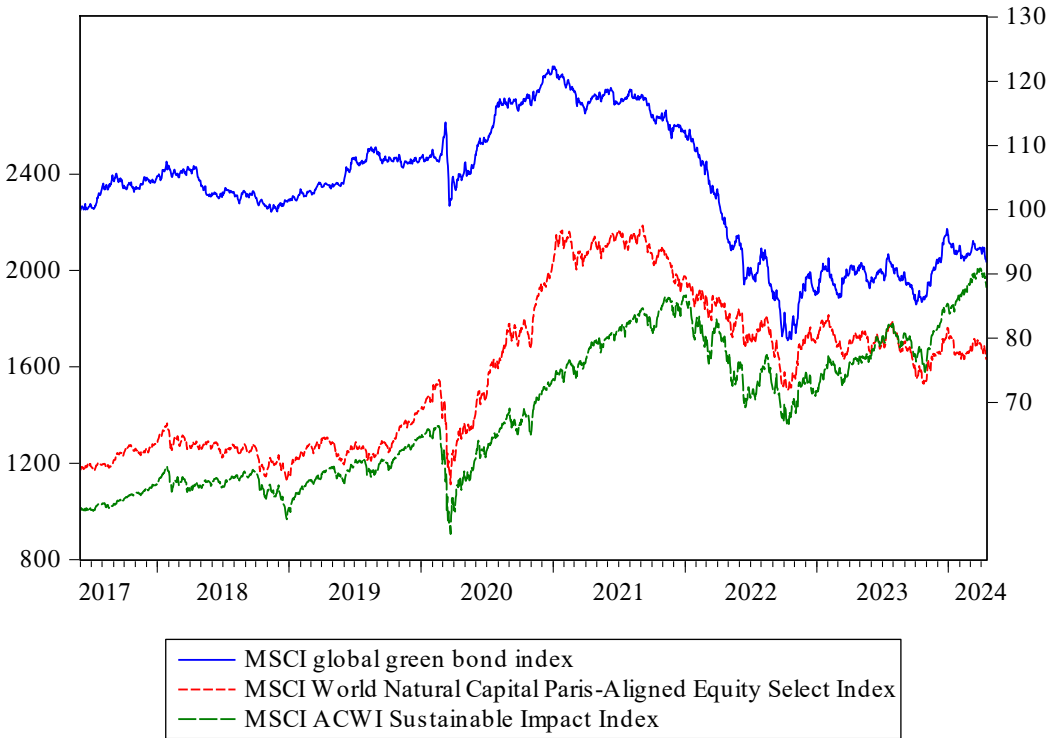

Figure 5. Time series plot for Sustainable Impact investments and Paris-aligned stock indexes (left vertical axis) and for the green bonds index (right vertical axis), June 2017–April 2024. Source: Authors' own research using data from Bloomberg.

3.2. QVAR Model

To assess quantile dependence and connectedness among the Sustainable Impact investments, Paris-aligned stocks, and green bonds indexes, we use a QVAR model with p lags as Chatziantoniou et al. (2021), given by:

$$y_t = \mu(\tau) + \sum_{j=1}^{p} A_j(\tau) y_{t-j} + \varepsilon_t(\tau) \quad (1)$$

where $y_t = (y_{1,t}, y_{2,t}, y_{3,t})'$ is a 3×1 vector of k endogenous variables at time $t = 1, \ldots, T$, and $\tau = (\tau_1, \tau_2, \tau_3)'$ is a 3×1 vector of quantiles of the conditional distribution of the variables included in y_t, with $\tau_s \in (0,1)$ for $s = 1,2,3$. $A_j(\tau)$ for $j = 1, \ldots, p$ is a 3×3 matrix of lagged coefficients in quantiles τ, where each element $a_{i,n}^{(j)}(\tau_i)$ differs across equations and accounts for the effect of the lag j of the variable n, $y_{n,t-j}$ in the τ_i-th quantile of the conditional distribution of the variable $y_{i,t}$. $\mu(\tau)$ is a 3×1 vector of intercepts in quantile τ, and $\varepsilon_t(\tau)$ is a 3×1 vector of residuals with a 3×3 variance–covariance matrix

$\Sigma(\tau)$. If the model is correctly specified, the conditional quantile of $\varepsilon_t(\tau)$ equals zero. Hence, the τ-th conditional of y_t is given by:

$$Q_\tau(y_t|y_{t-1},\ldots,y_{t-p}) = \mu(\tau) + \sum_{j=1}^{p} A_j(\tau)y_{t-j} \quad (2)$$

The QVAR model in Equation (1) can be estimated—for a given value of τ and assuming that the value of p for the conditional mean model is valid for any conditional quantile—using quantile regressions equation by equation, computed for the τ_i-th quantile of each variable i as follows:

$$\min_{\mu_i(\tau_i),a_{i,n}^{(j)}(\tau_i)} \sum_{t=1}^{T} \rho\Big(y_{it} - \mu_i(\tau_i) - \sum_{j=1}^{p}\sum_{n=1}^{k} a_{i,n}^{(j)}(\tau_i)y_{t-j}\Big), \quad (3)$$

where $\rho(x) = x\Big(\tau_i - 1_{\{x<0\}}\Big)$ is the usual check function for quantile regressions.

From Wold's representation of the QVAR(p) model in Equation (1), we can assess the accumulated effects of a quantile shock over future horizons as follows:

$$y_t = v(\tau) + \sum_{h=0}^{\infty} \Psi_h(\tau)\varepsilon_{t-h}(\tau), \quad (4)$$

where $\Psi_h(\tau) = A_1(\tau)\Psi_{h-1}(\tau) + \cdots + A_p(\tau)\Psi_{h-p}(\tau)$ are the moving average (MA) coefficients, where $\Psi_0(\tau)$ is the kxk identity matrix and $\Psi_h(\tau) = 0$ for $h < 0$, and where $v(\tau) = \sum_{h=0}^{\infty}\Psi_h(\tau)\mu(\tau)$. Assuming that the quantile vector τ is fixed over the forecast horizon under analysis, the vector of forecast errors for the prediction of y_{t+h} and the τ-th quantile is given by $e_{t+h}(\tau) = \sum_{l=0}^{h}\Psi_l(\tau)(u(\tau) + \varepsilon_{t+h-l}(\tau))$, and the forecast error variance is given by $\Sigma_{e_{t+h}}(\tau) = \sum_{l=0}^{h}\Psi_l(\tau)\Sigma(\tau)\Psi_l'(\tau)$. Thus, the impact of a shock in the τ-th quantile of a variable j on variable i is derived by Pesaran and Shin (1998) as follows:

$$\theta_{ij}^{(h)}(\tau) = \frac{\Sigma_{jj}(\tau)^{-1}\sum_{l=0}^{h}\big(e_i\Psi_l(\tau)\Sigma(\tau)e_j\big)^2}{\sum_{l=0}^{h} e_i'\Psi_l(\tau)\Sigma(\tau)\Psi_l'(\tau)e_i} \quad (5)$$

where $\Sigma_{jj}(\tau)$ denotes the j-th diagonal element of $\Sigma(\tau)$, and e_i denotes a zero vector with 1 in the i-th position. $\theta_{ij}^{(h)}(\tau)$ is normalized as $\overset{\sim}{\theta}_{ij}^{(h)}(\tau) = \theta_{ij}^{(h)}(\tau)/\sum_{j=1}^{k}\theta_{ij}^{(h)}(\tau)$, so $\sum_{j=1}^{k}\overset{\sim}{\theta}_{ij}^{(h)}(\tau) = 1$. Then, we can set up a spillover matrix with elements given by $\overset{\sim}{\theta}_{ij}^{(h)}(\tau)$ that accounts for the contribution that a shock in the quantile of a variable has on the quantiles of the other variables. Furthermore, the total information that a quantile of the variable i receives from the quantiles of the other variables derives as $C_{i\leftarrow j}(\tau) = \sum_{j=1,j\neq i}^{k}\overset{\sim}{\theta}_{ij}^{(h)}(\tau)$, so the net influence received by the variable i in the network in the τ-th quantile derives as $C_{i\leftarrow j}(\tau) - C_{j\leftarrow i}(\tau)$, with positive (negative) values indicating that i is a net receiver (transmitter). Finally, the total connectedness index (TCI) can be computed as the average impact of a shock in one series coming from another series, i.e., $\frac{1}{k-1}\sum_{j=1,j\neq i}^{k}\overset{\sim}{\theta}_{ij}^{(h)}(\tau)$.

4. Results and Discussion

Using the Bayesian information criterion (BIC), we estimate the QVAR model using one lag, and compute spillovers for a 20-day horizon ($h = 20$) for extreme and median quantiles: $\tau = 0.05, 0.5, 0.95$. Table 3 presents evidence of connectedness between sustainable securities, indicating that spillover transmission differs widely depending on market conditions. Thus, sustainable markets are closely connected in times of upward or downward price movements, whereas sustainable investments in a calm market are considerably decoupled, offering investors more diversification opportunities. With positive net spillover effects, Sustainable Impact investments and the Paris-aligned stocks index are net transmitters, whereas the green bonds index is net receiver of spillovers.

Table 3. Connectedness between sustainable investments under different market conditions.

	τ=0.05			τ=0.5			τ=0.95		
	To	**From**	**Net**	**To**	**From**	**Net**	**To**	**From**	**Net**
Sustainable Impact investments index	64.8	61.5	3.3	48.6	45.7	2.9	64.0	60.7	3.3
Paris-aligned stock index	63.1	60.3	2.8	47.6	42.5	5.1	62.0	59.9	2.1
Green bonds index	51.0	57.0	−6.0	11.2	19.1	−7.9	49.8	55.2	−5.4

Note. For different quantiles, this table presents spillovers transmitted from (to) each series in the first column to (from) the remaining series, computed as $C_{i\leftarrow j}(\tau)$ and $C_{j\leftarrow i}(\tau)$, respectively, and the net effect (to minus from). Spillovers are computed from a QVAR model with one lag. Source: Authors' own research using data from Bloomberg.

We assess whether previous spillover evidence differs over time due to specific events, such as the COVID-19 pandemic, the Russia–Ukraine conflict, and the changed EU and US monetary policies in 2022–2023. Therefore, we estimate the QVAR model using a 200-day rolling window that is moved forward daily. The graphical evidence in Figure 6 indicates that the spillover values given by the total connectedness index differ across quantiles and over time. We corroborate that spillovers are stronger in the extreme quantiles than in the median quantiles and are similar in size at the lower and upper tails, and that the temporal dynamics of spillovers is shaped by specific events, particularly in the median quantile. Thus, the COVID-19 pandemic, the Russia–Ukraine conflict, and the US and EU interest rate hikes intensified connectedness, corroborating previous studies (Zhang et al. 2023), and highlighting the relevance of major events on the hedging possibilities of sustainability-oriented investors using different sustainable securities.

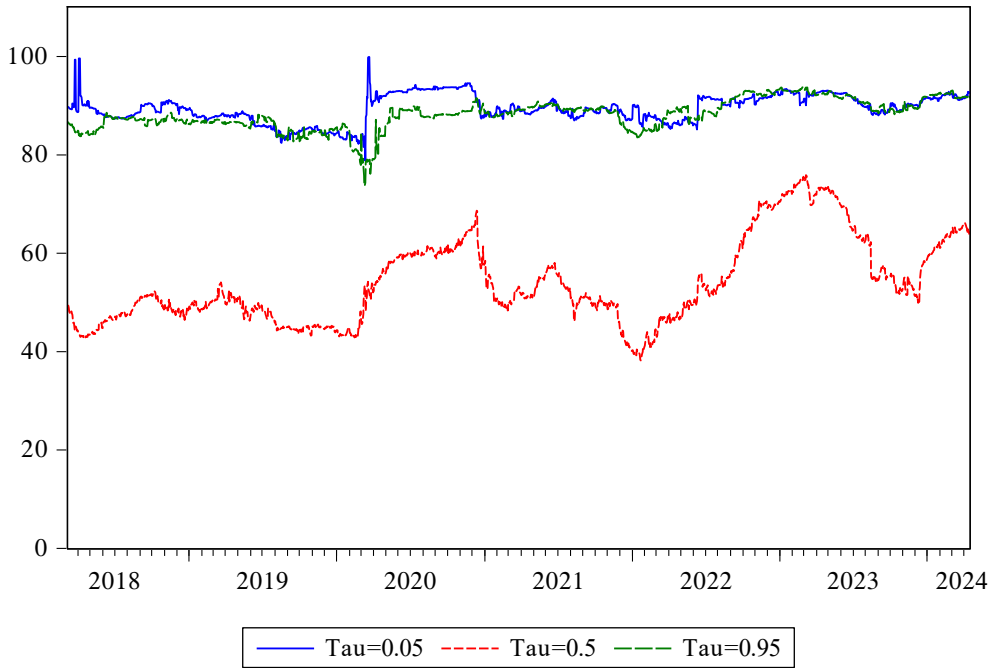

Figure 6. Total dynamic spillovers across quantiles between the indexes of Sustainable Impact investments, Paris-aligned stocks, and green bonds. Source: Authors' own research using data from Bloomberg.

In Figure 7, we analyze the Dynamic Total Connectedness (TCI); those with greater connectedness levels are depicted in warmer shades. Also, positive and negative price changes (above 75% and below 25% quantiles) show strong linkages throughout the sample period. The 50% quantile corresponds to the average TCI, revealing a pattern in market

linkage driven by special events, supported by average solid TCI in 2020, 2022, and 2023. The COVID-19 pandemic, the Russia–Ukraine conflict, and the US and European interest hikes demonstrate significant interconnectedness, aligning with previous studies (Zhang et al. 2023) and emphasizing the profound impact of the recent events on an interconnected system of sustainability synergy indexes.

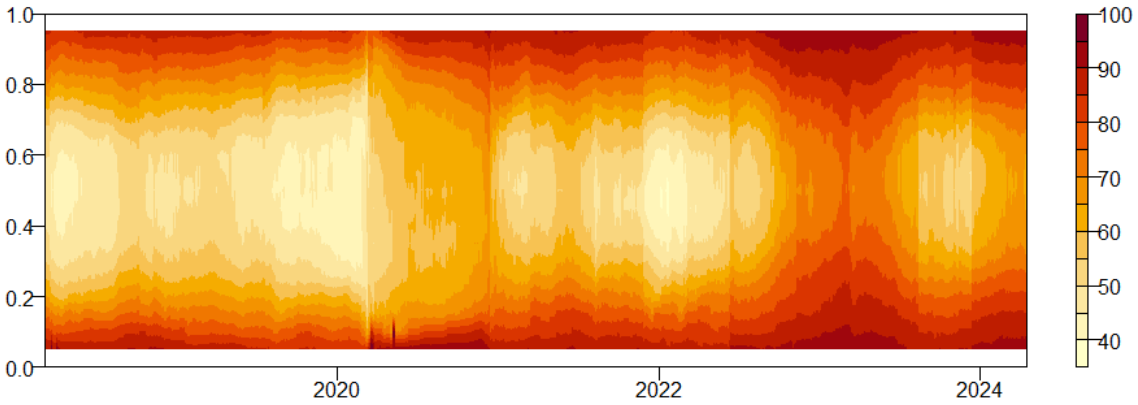

Figure 7. Total dynamic spillovers across quantiles between the indexes of Sustainable Impact investments, Paris-aligned stocks, and green bonds. Source: Authors' elaboration, with data gathered from Bloomberg. Notes: We took lags = 1 based on SIC for a 200-day rolling-window with a forecast horizon of 20 days. Those with greater connectedness levels are depicted in warmer shades, indicating stronger linkages. Positive and negative price changes (above 75% and below 25% quantiles) show robust connections throughout the sample period. Source: Authors' own research using data from Bloomberg.

Figure 8 provides detailed evidence of net spillovers for the three sustainable investment indexes across quantiles and over time. As in Chatziantoniou et al. (2021), warm (cold) shaded areas indicate net-transmitting (net-receiving) effects. Accordingly, Sustainable Impact investments are net transmitters to other sustainable securities over the sample period, with an intensity that is accentuated in the upper and lower quantiles in 2020 and after mid-2022. In contrast, the Paris-aligned stocks index strongly transmit net spillovers during the second semester of 2020 and 2022 across all quantiles but have a limited impact in the remaining sample periods. This evidence points to the fact that the influence of the Paris-aligned stocks index on other sustainable securities is circumscribed to specific periods and is independent of market conditions. Finally, green bonds behave as net receivers of impacts over the sample period in the extreme quantiles, particularly during the second semester of 2020 and in 2022. The size of the net impacts received by the green bonds index fluctuates over the sample period, with stronger net impact during the later periods of the sample, revealing that green bonds lack leadership in the transmission of shocks between sustainable investments; this can be explained by the relatively small size and low volatility of the fixed-income investments concerning stock investments.

Overall, our results reveal that sustainable investments closely co-move, particularly in extreme quantiles and at times of disruptive events. However, the intensity of this co-movement differs across securities; as a more disconnected sustainable asset class, green bonds are net receivers and so have a relevant role as de-risking assets for sustainable investments, such as Sustainable Impact investments or the Paris-aligned stock indexes. Potential explanations of our evidence can be related to (a) shifts in investor sentiment and environmental awareness, in particular around relevant events; (b) the leadership of the Sustainable Impact Index over the other two indexes, underscoring the increasing importance of a holistic approach to sustainability investment, given that this index encompasses both environmental and social factors that may be more in line with investor preferences; and (c) the growth of the sustainable investing industry, which has contributed to interconnectedness between different asset classes reflecting social and environmental issues.

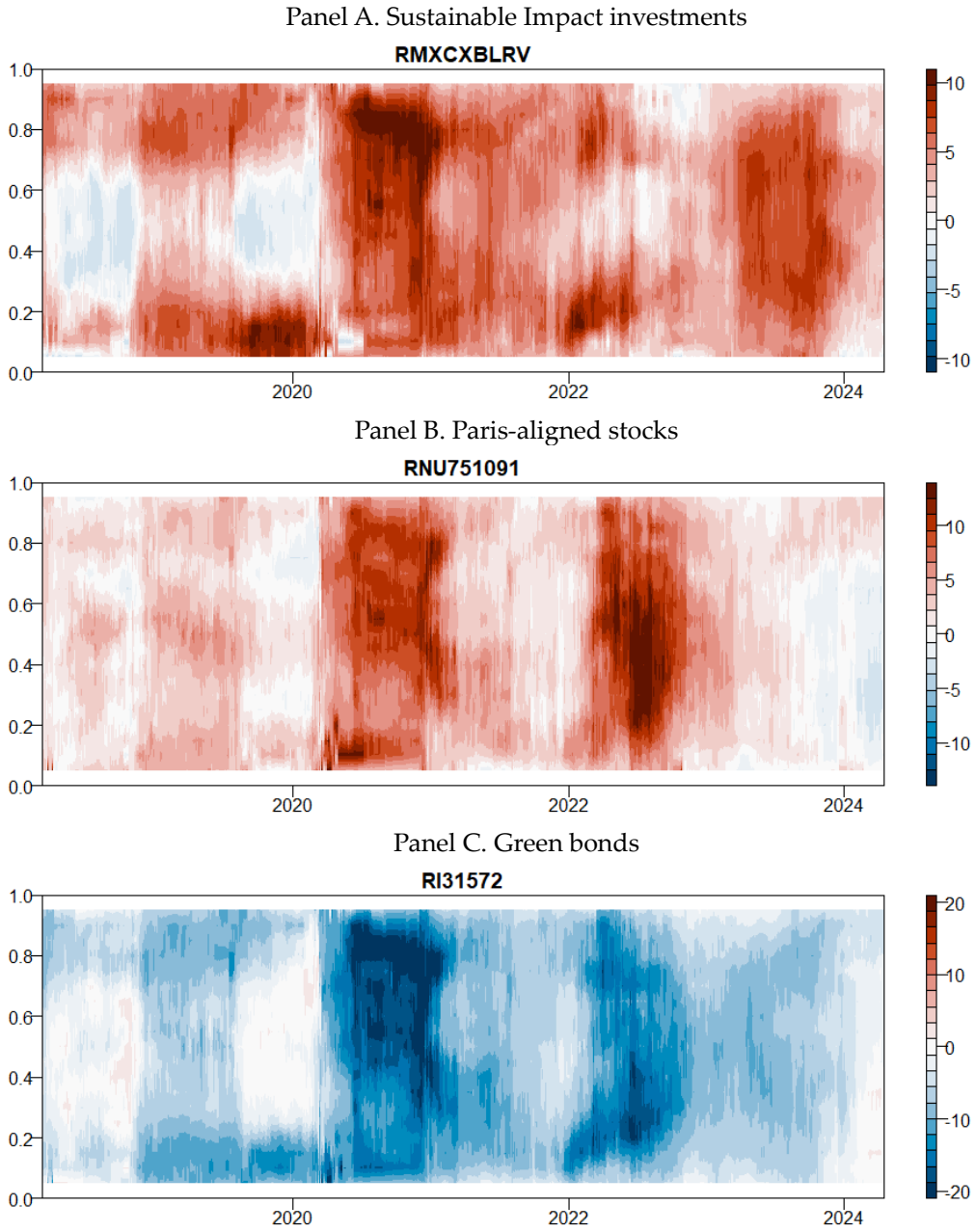

Figure 8. Net dynamic connectedness of the indexes of Sustainable Impact investments, Paris-aligned stocks, and green bonds. Notes: Warm (cold) shaded areas indicate periods of net-transmitting (net-receiving) effects across the indexes. Source: Authors' own research using data from Bloomberg.

Our results underscore the critical role of understanding transmission mechanisms and network structures in shaping effective investment strategies that simultaneously promote environmental sustainability and financial stability. Similar to Chuliá et al. (2017), Yaya et al. (2024), and Cocca et al. (2024), our findings emphasize the importance of integrated approaches that leverage market interdependencies to support portfolio resilience, manage risks, and foster sustainable economic growth. By synthesizing findings from global financial markets, African stock exchanges, and clean energy sectors, our study contributes to a holistic understanding of interconnectedness in contemporary financial landscapes. This holistic view is crucial for guiding policymakers and investors in developing strategies that align financial objectives with sustainability goals, thereby advancing both economic resilience and environmental stewardship on a global scale.

5. Conclusions

This study analyzes the dynamic connectedness and spillover effects among prominent sustainable investment indexes, such as the Paris-aligned stocks index, the Sustainable Impact Index, and the Global Green Bond Index, using a quantile connectedness approach for the empirical analyses. This approach is pivotal in studies examining dynamic connectedness and spillover networks (Ando et al. 2022; Chatziantoniou et al. 2021; Elsayed et al. 2022; Joo and Park 2023; Karim et al. 2022). Moreover, we perform a comprehensive empirical analysis employing the rolling-window technique to examine alterations in interconnectedness and transmission effects during market events. This analysis explores time-varying features of financial markets in their spillovers. The indexes uniquely reflect key facets of sustainable and socially responsible investing, encompassing environmental impact and broader ESG considerations in Eurozone corporate settings. This exploration provides valuable insights for investors, researchers, and policymakers as they navigate the multifaceted terrain of ESG investing, ultimately contributing to more informed decision-making and a more sustainable and equitable future.

Our findings reveal that sustainable investments are especially connected in the upper and lower quantiles, and that Sustainable Impact investments are a net transmitter of impacts to the other sustainable alternatives, i.e., green bonds and Paris-aligned investments. In contrast, the connection between sustainable investments substantially weakens when financial markets are calmed, i.e., in intermediate quantiles. Finally, we also identify increased connectedness across all quantiles during the pandemic period, during the Russia–Ukraine conflict, and with the changed EU and US monetary policies after mid-2022.

The interconnectedness of sustainable investments is crucial for several theoretical and practical reasons. Theoretically, understanding these connections provides a deeper insight into the dynamics and dependencies within the sustainable finance sector. This knowledge contributes to the financial literature by revealing how different sustainable investment vehicles interact under varying market conditions, such as bull, bear, and calm periods. By examining these interactions, we can better understand the mechanisms through which shocks and volatility are transmitted across different types of sustainable investments. This enhances our comprehension of market behavior and the systemic risks associated with sustainable finance.

This interconnectedness has significant implications for investors, policymakers, and portfolio managers. For investors, understanding the relationships between different sustainable investments can inform better portfolio diversification strategies. By identifying which investments are likely to be affected by common shocks or market events, investors can make more informed decisions to optimize their portfolios, balancing financial returns with sustainability goals. For policymakers, insights into the connectedness of sustainable investments can guide the design of regulatory frameworks and support mechanisms. This is particularly important during periods of market instability, where coordinated policies can help stabilize sustainable investment flows and ensure continued progress towards achieving the Sustainable Development Goals (SDGs).

Our evidence also has implications for investment decisions by sustainability-conscious investors. Although there is a growing demand for sustainable investment themes in public equity markets, investments through an SDG lens need to identify which are specifically oriented to the SDGs and how they co-move with alternative sustainable investments. The results indicate that sustainable investors can find hedging opportunities within the set of sustainable asset classes, particularly using green bonds, although those opportunities are less attractive in times of abrupt financial market movements. Therefore, public support of sustainable investments should be concentrated in times of extreme conditions in financial markets, when investments might flock to non-sustainable assets because investors find it more difficult to diversify their sustainable assets.

While our study provides valuable insights into the dynamic connectedness and spillover effects among prominent sustainable investment indexes, several limitations should be acknowledged. For example, our empirical analysis using the rolling-window

technique allows us to examine alterations in interconnectedness and transmission effects during market events, but it may not capture all nuances of market dynamics, especially in rapidly changing or extreme conditions. Moreover, our focus on Eurozone corporate settings may limit the generalizability of our findings to other geographic regions or market contexts. Additionally, while our study identifies increased connectedness across all quantiles during significant events, such as the COVID-19 pandemic and geopolitical conflicts, the causal mechanisms underlying these connections may require further investigation. Despite these limitations, our study contributes to understanding sustainable investment dynamics and provides valuable insights for the investors, researchers, and policymakers navigating the complexities of ESG investing.

Future research should focus on the impact of uncertainty on sustainable investments (Marín-Rodríguez et al. 2023a). Understanding how economic, geopolitical, and environmental uncertainties affect these investments will provide valuable insights into their resilience, and guide investors and policymakers in managing risks in sustainable finance strategies. Additionally, future research could analyze the relation among the sustainable investment indexes using longer investment horizons due to the preference of some investors to make long-term investments (Saeed et al. 2021). Then, the analysis can be conducted using lower frequency data (e.g., weekly or monthly) and considering the diverse investment horizons of different investors (Marín-Rodríguez et al. 2023b). This approach could provide more comprehensive insights into the behavior of sustainable investments over varying timeframes.

Lastly, exploring the connectedness between the selected indexes and including the S&P Global Clean Energy Index in the analysis could provide additional valuable insights. This comparison could reveal how sustainable investments perform relative to a widely recognized benchmark in the clean energy sector, offering a broader context for understanding their financial dynamics and market interactions.

Author Contributions: Conceptualization, N.J.M.-R.; methodology, N.J.M.-R. and J.D.G.-R.; validation, J.D.G.-R. and S.B.; formal analysis N.J.M.-R., J.D.G.-R. and S.B.; investigation N.J.M.-R. and J.D.G.-R.; data curation N.J.M.-R.; writing—review and editing, N.J.M.-R., J.D.G.-R. and S.B. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Datasets are available on request.

Acknowledgments: We want to extend our sincere gratitude to the four anonymous reviewers for their insightful comments and constructive feedback, which have significantly improved the quality of this study. We also thank the editor for their professional handling of the review process and their valuable guidance. Their efforts and expertise have helped shape this work.

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

References

Agrawal, Anirudh, and Kai Hockerts. 2021. Impact Investing: Review and Research Agenda. *Journal of Small Business & Entrepreneurship* 33: 153–81. [CrossRef]

Ando, Tomohiro, Matthew Greenwood-Nimmo, and Yongcheol Shin. 2022. Quantile Connectedness: Modeling Tail Behavior in the Topology of Financial Networks. *Management Science* 68: 2401–31. [CrossRef]

Aras, Güler, and David Crowther. 2009. Corporate Sustainability Reporting: A Study in Disingenuity? *Journal of Business Ethics* 87: 279–88. [CrossRef]

Athari, Seyed Alireza. 2024. Does the Sovereign Environmental, Social, and Governance Sustainability Activities Jeopardize the Banking Sector's Stability: Evidence from the Arab Economies. *Sustainable Futures* 7: 100204. [CrossRef]

Auer, Benjamin R. 2016. Do Socially Responsible Investment Policies Add or Destroy European Stock Portfolio Value? *Journal of Business Ethics* 135: 381–97. [CrossRef]

Becchetti, Leonardo, Rocco Ciciretti, Ambrogio Dalò, and Stefano Herzel. 2015. Socially Responsible and Conventional Investment Funds: Performance Comparison and the Global Financial Crisis. *Applied Economics* 47: 2541–62. [CrossRef]
Bei, Jinlan, and Chunyu Wang. 2023. Renewable Energy Resources and Sustainable Development Goals: Evidence Based on Green Finance, Clean Energy and Environmentally Friendly Investment. *Resources Policy* 80: 103194. [CrossRef]
Beisenbina, Marzhan, Laura Fabregat-Aibar, Maria-Glòria Barberà-Mariné, and Maria-Teresa Sorrosal-Forradellas. 2023. The Burgeoning Field of Sustainable Investment: Past, Present and Future. *Sustainable Development* 31: 649–67. [CrossRef]
BinMahfouz, Saeed, and M. Kabir Hassan. 2013. Sustainable and Socially Responsible Investing. *Humanomics* 29: 164–86. [CrossRef]
Bisaga, Iwona, Priti Parikh, Julia Tomei, and Long Seng To. 2021. Mapping Synergies and Trade-Offs between Energy and the Sustainable Development Goals: A Case Study of off-Grid Solar Energy in Rwanda. *Energy Policy* 149: 112028. [CrossRef]
Bodhanwala, Shernaz, and Ruzbeh Bodhanwala. 2018. Does Corporate Sustainability Impact Firm Profitability? Evidence from India. *Management Decision* 56: 1734–47. [CrossRef]
Bodhanwala, Shernaz, and Ruzbeh Bodhanwala. 2019. Relationship between Sustainable and Responsible Investing and Returns: A Global Evidence. *Social Responsibility Journal* 16: 579–94. [CrossRef]
Bugg-Levine, Antony, and Jed Emerson. 2011. Impact Investing: Transforming How We Make Money While Making a Difference. *Innovations: Technology, Governance, Globalization* 6: 9–18. [CrossRef]
Camilleri, Mark Anthony. 2020. The Market for Socially Responsible Investments. In *Corporate social responsibility (CSR) and Socially Responsible Investing Strategies in Transitioning and Emerging Economies*. London: IGI Global, pp. 171–88. [CrossRef]
Camilleri, Mark Anthony. 2021. The Market for Socially Responsible Investing: A Review of the Developments. *Social Responsibility Journal* 17: 412–28. [CrossRef]
Çatak, Ç. 2024. The Confusion over the Terminology of Sustainable, ESG, Socially Responsible and Impact Investing. In *Sustainable Finance: Challenges, Opportunities and Future Prospects*. Lausanne: Peter Lang AG, pp. 45–58.
Chatziantoniou, Ioannis, David Gabauer, and Alexis Stenfors. 2021. Interest Rate Swaps and the Transmission Mechanism of Monetary Policy: A Quantile Connectedness Approach. *Economics Letters* 204: 109891. [CrossRef]
Chatzitheodorou, Kyriakos, Antonis Skouloudis, Konstantinos Evangelinos, and Ioannis Nikolaou. 2019. Exploring Socially Responsible Investment Perspectives: A Literature Mapping and an Investor Classification. *Sustainable Production and Consumption* 19: 117–29. [CrossRef]
Chuliá, Helena, Montserrat Guillén, and Jorge M. Uribe. 2017. Spillovers from the United States to Latin American and G7 Stock Markets: A VAR Quantile Analysis. *Emerging Markets Review* 31: 32–46. [CrossRef]
Cocca, Teodoro, David Gabauer, and Stefan Pomberger. 2024. Clean Energy Market Connectedness and Investment Strategies: New Evidence from DCC-GARCH R2 Decomposed Connectedness Measures. *Energy Economics* 136: 107680. [CrossRef]
Daugaard, Dan, Jing Jia, and Zhongtian Li. 2024. Implementing Corporate Sustainability Information in Socially Responsible Investing: A Systematic Review of Empirical Research. *Journal of Accounting Literature* 46: 238–76. [CrossRef]
Delle Foglie, Andrea, and J.S. Keshminder. 2022. Challenges and Opportunities of SRI Sukuk toward Financial System Sustainability: A Bibliometric and Systematic Literature Review. *International Journal of Emerging Markets*. [CrossRef]
Dickey, David A., and Wayne A Fuller. 1979. Distribution of the Estimators for Autoregressive Time Series with a Unit Root. *Journal of the American Statistical Association* 74: 427–31. [CrossRef]
ElBannan, Mona A. 2024. Returns Behavior of ESG ETFs in the COVID-19 Market Crash: Are Green Funds More Resilient? *Journal of Corporate Accounting & Finance* 35: 187–223. [CrossRef]
Elsayed, Ahmed H., Giray Gozgor, and Larisa Yarovaya. 2022. Volatility and Return Connectedness of Cryptocurrency, Gold, and Uncertainty: Evidence from the Cryptocurrency Uncertainty Indices. *Finance Research Letters* 47: 102732. [CrossRef]
Entine, Jon. 2003. The Myth of Social Investing. *Organization & Environment* 16: 352–68. [CrossRef]
Geczy, Christopher C., Robert F Stambaugh, and David Levin. 2021. Investing in Socially Responsible Mutual Funds. *The Review of Asset Pricing Studies* 11: 309–51. [CrossRef]
Gil-Bazo, Javier, Pablo Ruiz-Verdú, and André A. P. Santos. 2010. The Performance of Socially Responsible Mutual Funds: The Role of Fees and Management Companies. *Journal of Business Ethics* 94: 243–63. [CrossRef]
Gillan, Stuart L., Andrew Koch, and Laura T. Starks. 2021. Firms and Social Responsibility: A Review of ESG and CSR Research in Corporate Finance. *Journal of Corporate Finance* 6: 101889. [CrossRef]
Hawn, Olga, Aaron K. Chatterji, and Will Mitchell. 2018. Do Investors Actually Value Sustainability? New Evidence from Investor Reactions to the Dow Jones Sustainability Index (DJSI). *Strategic Management Journal* 39: 949–76. [CrossRef]
Heine, Dirk, Willi Semmler, Mariana Mazzucato, Joao Paulo Braga, Arkady Gevorkyan, Erin Kate Hayde, and Siavash Radpour. 2019. Financing Low-Carbon Transitions Through Carbon Pricing and Green Bonds. Working Paper No. 8991. Available online: https://documents1.worldbank.org/curated/en/808771566321852359/pdf/Financing-Low-Carbon-Transitions-through-Carbon-Pricing-and-Green-Bonds.pdf (accessed on 15 April 2024).
He, Jianjian, Yi Yang, Zhongju Liao, Anqi Xu, and Kai Fang. 2022. Linking SDG 7 to Assess the Renewable Energy Footprint of Nations by 2030. *Applied Energy* 317: 119167. [CrossRef]
Iqbal, Najaf, Muhammad Abubakr Naeem, and Muhammed Tahir Suleman. 2022. Quantifying the Asymmetric Spillovers in Sustainable Investments. *Journal of International Financial Markets, Institutions and Money* 77: 101480. [CrossRef]
Jonwall, Renu, Seema Gupta, and Shuchi Pahuja. 2023. Socially Responsible Investment Behavior: A Study of Individual Investors from India. *Review of Behavioral Finance* 15: 865–88. [CrossRef]

Joo, Young C., and Sung Y. Park. 2023. Quantile Connectedness between Cryptocurrency and Commodity Futures. *Finance Research Letters* 58: 104472. [CrossRef]
Kapil, Sheeba, and Vrinda Rawal. 2023. Sustainable Investment and Environmental, Social, and Governance Investing: A Bibliometric and Systematic Literature Review. *Business Ethics, the Environment & Responsibility* 32: 1429–51. [CrossRef]
Karim, Sitara, Brian M. Lucey, Muhammad Abubakr Naeem, and Gazi Salah Uddin. 2022. Examining the Interrelatedness of NFTs, DeFi Tokens and Cryptocurrencies. *Finance Research Letters* 47: 102696. [CrossRef]
Marín-Rodríguez, Nini Johana, Juan David González-Ruiz, and Alejandro Valencia-Arias. 2023a. Sustainability, Uncertainty, and Risk: Time-Frequency Relationships. *Sustainability* 15: 13589. [CrossRef]
Marín-Rodríguez, Nini Johana, Juan David González-Ruiz, and Sergio Botero. 2022. Dynamic Relationships among Green Bonds, CO_2 Emissions, and Oil Prices. *Frontiers in Environmental Science* 10: 992726. [CrossRef]
Marín-Rodríguez, Nini Johana, Juan David González-Ruiz, and Sergio Botero. 2023b. A Wavelet Analysis of the Dynamic Connectedness among Oil Prices, Green Bonds, and CO_2 Emissions. *Risks* 11: 15. [CrossRef]
McLachlan, Jonathan, and John Gardner. 2004. A Comparison of Socially Responsible and Conventional Investors. *Journal of Business Ethics* 52: 11–25. [CrossRef]
Muñoz, Fernando. 2021. Carbon-Intensive Industries in Socially Responsible Mutual Funds' Portfolios. *International Review of Financial Analysis* 75: 101740. [CrossRef]
Nerini, Francesco, Benjamin Sovacool, Nick Hughes, Laura Cozzi, Ellie Cosgrave, Mark Howells, Massimo Tavoni, Julia Tomei, Hisham Zerriffi, and Ben Milligan. 2019. Connecting Climate Action with Other Sustainable Development Goals. *Nature Sustainability* 2: 674–80. [CrossRef]
Pástor, L'uboš, Robert F. Stambaugh, and Lucian A. Taylor. 2022. Dissecting Green Returns. *Journal of Financial Economics* 146: 403–24. [CrossRef]
Pesaran, H. Hashem, and Yongcheol Shin. 1998. Generalized Impulse Response Analysis in Linear Multivariate Models. *Economics Letters* 58: 17–29. [CrossRef]
Reboredo, Juan C., and Luis A. Otero. 2021. Are Investors Aware of Climate-Related Transition Risks? Evidence from Mutual Fund Flows. *Ecological Economics* 189: 107148. [CrossRef]
Reboredo, Juan C., Andrea Ugolini, and Javier Ojea-Ferreiro. 2022. Do Green Bonds De-Risk Investment in Low-Carbon Stocks? *Economic Modelling* 108: 105765. [CrossRef]
Robledo, Sebastian, Martha Zuluaga, Luis-Alexander Valencia-Hernandez, Oscar Arbelaez-Echeverri Arbelaez-Echeverri, Pedro Duque, and Juan-David Alzate-Cardona. 2022. Tree of Science with Scopus: A Shiny Application. *Issues in Science and Technology Librarianship*. [CrossRef]
Sabbaghi, Omid. 2011. Do Green Exchange-Traded Funds Outperform the S&p500. *Journal of Accounting and Finance* 11: 50–59.
Saeed, Tareq, Elie Bouri, and Hamed Alsulami. 2021. Extreme Return Connectedness and Its Determinants between Clean/Green and Dirty Energy Investments. *Energy Economics* 96: 105017. [CrossRef]
Sinclair, Stéfan, and Geoffrey Rockwell. 2020. Voyant-Tools. Available online: http://voyant-tools.org/ (accessed on 13 April 2024).
Singhania, Monica, Ibna Bhan, and Gurmani Chadha. 2024. Sustainable Investments: A Scientometric Review and Research Agenda. *Managerial Finance* 50: 266–94. [CrossRef]
Taghizadeh-Hesary, Farhad, and Naoyuki Yoshino. 2019. The Way to Induce Private Participation in Green Finance and Investment. *Finance Research Letters* 31: 98–103. [CrossRef]
Talan, Gaurav, and Gagan Sharma. 2019. Doing Well by Doing Good: A Systematic Review and Research Agenda for Sustainable Investment. *Sustainability* 11: 353. [CrossRef]
Umar, Zaghum, Dimitris Kenourgios, and Sypros Papathanasiou. 2020. The Static and Dynamic Connectedness of Environmental, Social, and Governance Investments: International Evidence. *Economic Modelling* 93: 112–24. [CrossRef] [PubMed]
United Nations. 2018. Unlocking SDG Financing: Findings from Early Adopters. United Nations Sustainable Development Group. Available online: https://unsdg.un.org/sites/default/files/Unlocking-SDG-Financing-Good-Practices-Early-Adopters.pdf (accessed on 14 April 2024).
van Eck, Nees Jan, and Ludo Waltman. 2017. Citation-Based Clustering of Publications Using CitNetExplorer and VOSviewer. *Scientometrics* 111: 1053–70. [CrossRef] [PubMed]
Yaya, OlaOluwa, Olayinka Adenikinju, and Hammed A. Olayinka. 2024. African Stock Markets' Connectedness: Quantile VAR Approach. *Modern Finance* 2: 51–68. [CrossRef]
Yoshino, Naoyuki, Farhad Taghizadeh-Hesary, and Miyu Otsuka. 2021. COVID-19 and Optimal Portfolio Selection for Investment in Sustainable Development Goals. *Finance Research Letters* 38: 101695. [CrossRef] [PubMed]
Zhang, He, Zhenting Gong, Yunglieh Yang, and Fan Chen. 2023. Dynamic Connectedness between China Green Bond, Carbon Market and Traditional Financial Markets: Evidence from Quantile Connectedness Approach. *Finance Research Letters* 58: 104473. [CrossRef]