Dissecting the tail: assessing global drivers of French sustainable markets

Amal Essayem
Institute of Islamic Economics and Finance (MUISEF), Marmara University, İstanbul, Türkiye

Received 1 May 2025
Revised 28 August 2025
2 October 2025
Accepted 2 October 2025

Abstract

Purpose – This study explores the dynamic and asymmetric effects of global major risks (specifically financial market volatility, geopolitical uncertainty, oil price fluctuations, and climate-related risks) on the performance of green financial assets in France. It aims to assess how these risk factors influence sustainable stock indices under varying market conditions, offering insights into the integration of sustainability within financial systems.

Design/methodology/approach – The study employs a quantile regression approach to capture the heterogeneous impacts of macro risks across the conditional distribution of sustainable stock returns. This method allows for the examination of tail behaviors and state-dependent sensitivities of green assets, using France's sustainable stock index as the focal point.

Findings – *Green bonds positively contribute to sustainable stock returns, although they limit diversification benefits. *Volatility indicators (VIX and OVX) exert nonlinear effects, with stronger influences observed during bullish markets. *Geopolitical risk does not show a statistically significant impact. *Both physical and transition climate risks consistently depress sustainable stock performance across all market conditions, underscoring the systemic nature of climate vulnerability.

Originality/value – This study offers a novel, country-specific analysis of how macro risks influence green financial assets, with a particular focus on France; a global leader in sustainable finance. By using a quantile regression framework, it provides fresh empirical evidence of asymmetric risk impacts and highlights the critical role of climate risks in shaping sustainable investment outcomes. The findings have practical implications for policymakers and financial institutions aiming to enhance market resilience and promote France's transition to a low-carbon economy.

Keywords ESG investing, Climate-related risks, Green bonds, Geopolitical risk, Quantile regression, France

Paper type Research article

1. Introduction

The accelerating pace of climate change and rising environmental risks have significantly reshaped global investment trends, directing greater attention toward clean energy and green financial assets. While investors are increasingly motivated to allocate capital to sustainable stocks, concerns remain regarding their comparative returns relative to conventional investments. At the same time, the evolving financial landscape, marked by geopolitical tensions and economic uncertainty, further complicates these investment choices.

Within this context, green finance has emerged as a pivotal mechanism for channeling both public and private capital toward initiatives that support sustainable development and deliver environmental benefits (Zhang *et al*., 2020, 2022). As the world strives to achieve the targets set by the Paris Agreement and the United Nations Sustainable Development Goals, the urgency to strengthen green finance has intensified. Green investments are vital not only for reaching a net-zero economy but also for ensuring a resilient recovery in the post-COVID-19 era. Yet, these efforts face mounting challenges from global risks, such as heightened

JEL Classification — G11, G15, G32, O16

Funding: No funding was received to assist with the preparation of this manuscript.

Conflict of interest: The authors have no conflicts of interest to declare.

Journal of Capital Markets Studies
Vol. 9 No. 2, 2025
pp. 214-234
Emerald Publishing Limited
2514-4774
DOI 10.1108/JCMS-05-2025-0055

geopolitical tensions, financial instability (Sadat and Gormus, 2025; Gaies and Chaâbane, 2024), and oil price volatility (Essayem *et al*., 2024; Alqahtani and Klein, 2021).

The intersection of green finance with financial uncertainty, oil price shocks, and geopolitical risk carries profound implications for both environmental and economic sustainability. Evidence suggests that while geopolitical tensions and financial stress tend to discourage green investment, oil price volatility and the expansion of renewable sectors may conversely encourage shifts toward greener assets (Wang *et al*., 2023; Lee *et al*., 2021). Understanding these dynamics is crucial because green financial instruments, including bonds and sustainable stocks, are not immune to external shocks. Despite their growing prominence, their resilience to macroeconomic and geopolitical disturbances remains underexplored (Banque de France, 2021).

Although traditional stock markets have been widely analyzed in relation to volatility, oil price shocks, and geopolitical instability, the response of green financial assets to these external pressures is still largely unclear. Given the structural and strategic differences between sustainability-driven investments and conventional assets, green stocks may exhibit unique risk-return dynamics, particularly in periods of global turbulence. Moreover, climate-related risks, both physical (extreme weather, sea-level rise) and transitional (e.g. regulatory or technological changes), have received limited attention despite their increasing importance. These risks not only impair firm operations and asset values but may also trigger systemic disruptions across financial markets (Carney, 2015; Battiston *et al*., 2017).

Narrowing this discussion to the national level, France offers a particularly insightful case. Recognized as a pioneer in sustainable finance, France has taken a leading role in developing green bond markets, advancing regulatory frameworks, and aligning financial practices with environmental goals (Agence France Trésor, 2023a, b). The resilience of French green equity markets, rising by 1.33% between January and July 2024, compared with the relative stability of the CAC 40, highlights investor interest in ESG-compliant assets. However, most existing studies focus on global or regional trends, often overlooking country-specific dynamics. For advanced economies like France, isolating national effects is critical to understanding how global macroeconomic risks shape green finance.

Despite progress in the literature, significant gaps remain regarding the effect of financial stress, oil price volatility, and geopolitical uncertainty on green asset performance at the country level. Furthermore, responses may be asymmetric, varying across different market conditions, which underscores the need for state-dependent analysis.

To address these gaps, this study investigates the dynamic relationship between global risk factors and green asset performance in France. Building on recent advances such as Wang *et al*. (2023), who applied QARDL model at a global scale, our analysis extends the scope by incorporating climate-related risks and by offering a granular, country-specific perspective. The contributions of this study are threefold: First, it provides a comprehensive integration of multiple global risk factors into a unified empirical framework; second, it applies quantile regression techniques to capture asymmetric and nonlinear dependencies; and third it delivers country-level insights for France, whose green equity market has outperformed peers among G7 economies (Bauer *et al*., 2022). By doing so, the paper offers practical implications for investors, policymakers, and financial institutions seeking to enhance the resilience of green assets.

The remainder of the paper is structured as follows: Section 2 reviews the literature; Section 3 describes the data and presents descriptive statistics; Section 4 outlines the methodology; Section 5 discusses the results; Section 6 presents robustness checks; and Section 7 concludes with key policy recommendations.

2. Literature review

The complexity of global financial systems and the urgent need for sustainability have pushed green finance to the forefront of economic policies worldwide. Financial instruments like

green bonds and ESG investments are now integral to funding the transition to a low-carbon economy (Climate Bonds Initiative, 2020). Recognizing this, France has made significant strides in developing a supportive policy environment, including launching its first green bond in 2017 and adopting legislation to promote climate risk disclosure. These efforts are part of France's broader commitment to climate action, exemplified by hosting the 2015 Paris Climate Agreement (United Nations, 2015).

French indices such as the CAC 40 ESG and the Low Carbon 100 Europe facilitate investments in sustainable companies, reinforcing France's leadership in green finance (sustainable finance in a broader sense). Given this strong policy environment, France provides a valuable case for exploring how external global shocks, like geopolitical tensions, oil price swings, and market volatility, impact green asset performance. While much of the existing literature covers green finance at an international level, detailed country-specific analyses, especially focusing on France, are limited (Auer and Schuhmacher, 2016). Because France has integrated climate policies with its financial markets, studying its experience can reveal how global risks influence sustainability assets.

This brings us to the investigation of one of the most critical global risk factors; geopolitical risk which can significantly influence financial markets and, by extension, sustainable investments.

2.1 Geopolitical risk

Frequent geopolitical tensions, wars, and international conflicts continue to impose substantial constraints on the development of green projects, thereby reducing incentives for sustainable investments. Although a growing body of research has investigated the link between geopolitical risks (GPR) and traditional financial market performance, the specific impact on green financial assets, particularly sustainable stock indices, remains significantly underexplored. This gap is especially critical given the distinct structural characteristics of green assets, which may cause them to respond differently to external shocks compared to conventional investments.

Existing studies have primarily focused on the relationship between GPR and asset returns in traditional markets (Balcilar *et al*., 2018; Bianchi, 2020; Caldara and Iacoviello, 2022; Qin *et al*., 2020). However, less attention has been devoted to volatility dynamics, which are crucial for understanding the risk exposure of green investments, especially during periods of heightened market stress. Unlike mature conventional markets, green financial markets (with sustainable equity indices)are relatively newer and potentially more vulnerable to geopolitical and macroeconomic shocks. This heightened sensitivity may cause their responses to global risks to be asymmetric across different market phases (bearish, normal, and bullish), an aspect that remains insufficiently addressed in the current literature.

Several transmission mechanisms have been proposed. Through a direct channel, geopolitical tensions may disrupt ongoing green projects, impede new sustainable initiatives, and thus lower the returns and stability of green assets (Flouros *et al*., 2022; Sweidan, 2021). Alternatively, via an indirect or spillover channel, shocks to conventional financial markets may prompt shifts in investor sentiment toward green investments, either as safe-haven assets or riskier alternatives, depending on the broader economic climate. However, the direction and magnitude of these effects are far from uniform and may vary with the intensity and type of geopolitical events.

Recent empirical studies underline this complexity. Zhang *et al*. (2023) show that the impact of GPR on green finance is both asset-specific and time-dependent. Their findings, based on a dynamic causality framework, reveal that geopolitical tensions affect the volatility of green bonds and renewable energy stocks more than their returns. Notably, while European clean energy markets have shown increased resilience since 2015, the influence of GPR remains significant at earlier stages. Similarly, Sohag *et al*. (2022) highlight that decomposed measures of geopolitical risk (acts, threats, broad/narrow indicators) differentially affect green

equities and bonds, with direct geopolitical acts exerting the most consistently negative impact, especially at extreme quantiles, suggesting that asymmetric effects across market states must be considered when assessing green asset behavior.

2.2 Green bonds

Following the increasing importance of geopolitical risks, another critical driver influencing the performance of sustainable stock markets is the rapid expansion of the global green bond market. Green bonds have emerged as a cornerstone of sustainable finance, channeling substantial capital flows toward environmentally responsible projects and aligning financial markets with climate change mitigation goals (Ehlers and Packer, 2017; Flammer, 2020). Their issuance by sovereigns, supranational institutions, and corporations has grown exponentially since the Paris Agreement of 2015, reflecting a broad-based commitment to support the transition toward a low-carbon economy (ICMA, 2021).

The expansion of the green bond market is expected to generate positive spillovers across broader financial markets, including equity markets, by improving corporate sustainability profiles, strengthening investor confidence, and mobilizing capital toward ESG-compliant firms. Several studies support the notion that green bond issuances can lead to improved stock market performance, particularly for firms closely associated with green projects (Wang *et al*., 2023; Flammer, 2021). The underlying mechanism is that green bond issuance signals a firm's commitment to sustainability, thus enhancing its attractiveness to investors increasingly focused on ESG criteria.

In this regard, France has established itself as a key player in green finance globally. French entities have been among the most active issuers of green bonds, with both sovereign (for instance the French government's landmark green bond issuance in 2017) and corporate issuers contributing significantly to the market's growth (Agence France Trésor, 2023a, b; World Bank, 2021). Despite these developments, the specific relationship between global green bond market performance and the behavior of French sustainable stock indices remains underexplored. While prior literature has examined the general impact of green bond issuances on firm-level stock returns (Flammer, 2021; Pereira *et al*., 2024), few studies have systematically analyzed how global green bond dynamics influence national sustainable indices, especially in the French context. Most existing research focuses on either global aggregate indices or isolated corporate case studies, leaving a significant gap regarding the broader market-level effects.

Furthermore, the green bond market's global expansion may influence French sustainable stock indices through several channels. First, global increases in green bond issuance can boost overall investor sentiment toward sustainable finance, potentially leading to higher valuations for ESG-compliant stocks. Second, capital reallocation in favor of green bonds may affect investment flows across different asset classes, including sustainable equities. Third, macroeconomic shocks (financial stress, oil price volatility, geopolitical tensions) may jointly impact both global green bond markets and national sustainable indices, though the direction and intensity of these effects are likely to be state-dependent. Recent empirical findings partially support these theoretical links. For instance, Wang *et al*. (2023) show that green investment activity, including green bond issuance, correlates positively with stock market performance under certain market conditions. However, direct studies examining how global green bond performance affects sustainable stock indices in specific countries like France remain rare.

2.3 Financial distress

Beyond geopolitical tensions and green bond market dynamics, financial distress and market volatility represent key macro-financial risks that critically influence the performance of sustainable financial assets. Several empirical studies document the sensitivity of green financial markets to spikes in financial distress. Fernandez-Rodríguez *et al*. (2016) initially

focused on the broader connection between financial stress and traditional asset classes, highlighting how systemic shocks in Financial Stress alter stock and bond market dynamics. Wang *et al*. (2023) find a strong and consistent negative relationship between broader financial stress and green investment activities. Their QARDL model results reveal that rising financial volatility significantly suppresses green bond issuance and investment, particularly at middle and higher quantiles. The explanation lies in heightened investor risk aversion during periods of market turbulence: green financial instruments, often perceived as longer-term, policy-sensitive investments, become relatively less attractive under such conditions. Gaies and Chaâbane (2024) further investigate this relationship using advanced techniques such as wavelet coherence and quantile-on-quantile regressions. Their findings show that increases in market volatility have a negative impact on green equity performance in both the U.S. and European markets, especially during bullish or highly volatile periods. Interestingly, they also detect a mild positive relationship under normal market conditions, suggesting that moderate volatility may, at times, increase investor interest in green stocks perceived as ethical or stable alternatives.

Focusing on the European context to which France belongs, empirical research increasingly confirms the importance of market volatility for sustainable and ESG-focused financial markets. Öcal and Kamil (2021), in their cross-country study including France, demonstrate that while the French ESG-X index is generally less sensitive to VIX shocks compared to the country's main market index. Further support comes from Iannone *et al*. (2025), who examine ESG investments across major European economies during global turmoil. Their findings reveal that French ESG portfolios exhibit relatively greater resilience under crisis conditions compared to conventional equities, absorbing volatility more effectively and suffering smaller losses. Complementary evidence is provided Gavrilakis and Floras (2024) highlight that volatility and herding biases play a distinct role in shaping the performance of European ESG leader portfolios. These studies converge on the conclusion that volatility exerts a significant influence on European sustainable stock markets.

2.4 Oil price volatility

Another important macroeconomic risk factor influencing the performance of green financial assets is oil price volatility, commonly proxied by the Oil Volatility Index (OVX). The interconnectedness between traditional energy markets and green finance (sustainable finance broadly speaking) has drawn increasing academic attention, especially as concerns about fossil fuel dependence and climate change have intensified. The relationship between oil prices and green investment is theoretically complex. On one hand, rising oil prices are expected to make renewable energy and clean technologies relatively more attractive, leading to increased investment in green financial assets (Sadorsky, 2008; Kumar *et al*., 2012; Managi and Okimoto, 2013). On the other hand, some studies argue for a decoupling hypothesis, suggesting that clean energy markets may behave independently from oil market fluctuations, particularly during extreme oil price movements (Kocaarslan and Soytas, 2019; Usman, 2023).

Empirical findings generally indicate that oil price volatility has a positive effect on green investments. Dutta *et al*. (2020), using a Markov regime-switching model, reveal a positive and dynamic association between oil price volatility and environmental investment. Similarly, Lee *et al*. (2021) identify a bidirectional causality between oil price shocks and green bond investment in the U.S. economy, highlighting that periods of oil market turbulence can reinforce green finance growth.

The interpretation behind these results often relies on the substitution effect: as oil markets become more volatile, investors and policymakers increasingly view clean energy investments as strategic hedges against fossil fuel dependency. Supporting this, Wang *et al*. (2023) find a positive and statistically significant relationship between OVX and green investment (GIN) across low, medium, and high quantiles. Their results suggest that higher oil price uncertainty

consistently encourages shifts toward green investments, particularly in clean energy sectors, thereby promoting sustainable finance even amid broader market instability.

Additional insights are offered by Shahbaz *et al.* (2021), who examine how energy and stock markets interact with clean energy returns under different market regimes. Their findings confirm that clean energy markets respond asymmetrically to oil market movements, with stronger sensitivity during extreme bullish or bearish phases. Interestingly, cross-correlogram analysis reveals that clean energy markets may diverge from conventional markets during optimistic stock market periods, indicating complex investor behavior patterns in green finance.

However, the evidence remains mixed regarding the strength and consistency of the oil-green finance relationship, particularly under extreme oil price conditions. Usman (2023), employing stochastic dominance tests, finds that while clean energy stocks generally outperform during normal oil market conditions, conventional energy stocks tend to dominate during periods of sharp upward oil price movements. This partial decoupling suggests that clean energy and sustainable investments exhibit distinct risk-return profiles compared to traditional energy sectors.

2.5 Climate-related uncertainty

Building upon the discussion above, it is essential to recognize that the broader landscape of climate risks also plays a pivotal role in shaping the performance of sustainable financial assets. Climate risks, both physical and transition-related, have gained significant attention as institutional investors, regulators, and academics attempt to quantify their implications for financial markets. Sustainable stock indices, designed to reflect environmental, social, and governance criteria, are often viewed as more resilient in the long term; however, their short-term performance remains susceptible to climate-related shocks (Krueger *et al*., 2020; Giglio *et al*., 2021).

The increasing integration of climate risks into financial markets reflects a growing recognition of their potential to affect asset values. Studies by Engle *et al*. (2020) highlight that firms with high exposure to climate risks, particularly those with high carbon intensity, tend to experience heightened return volatility and increased capital costs. As investors assess climate risks more thoroughly, many are reallocating their portfolios to better align with environmental considerations (Bolton and Kacperczyk, 2021). For example, Borghesi *et al*. (2022) finds that green announcements related to the transition to sustainable energy in European countries positively impact green portfolios, reflecting the broader market's growing attention to climate-conscious investments.

However, certain ESG-heavy sectors—such as renewable energy, agriculture, and water utilities—are more directly exposed to physical climate events. Research by Klusak *et al*. (2023) shows that physical climate risks, such as extreme weather events, can significantly depress the valuations of firms located in vulnerable regions. This effect is particularly pronounced during bearish market conditions, where increased risk aversion leads to a retreat of capital from sectors perceived as volatile.

While sustainable firms are typically aligned with the goals of a low-carbon transition, they are not immune to the risks associated with this transition. Regulatory changes (carbon taxes, disclosure mandates) and shifts in innovation can create substantial compliance and investment costs for firms (Battiston *et al*., 2017; TCFD, 2017). Thus, even sectors that benefit from the green transition, such as renewable energy, may face significant risks. Ironically, climate-driven investments themselves are vulnerable to environmental disruptions. Extreme weather events (floods, hurricanes, and wildfires) can disrupt renewable energy production and damage infrastructure, leading to volatility in green stock returns (Bansal *et al*., 2016).

Moreover, to achieve the green transition from traditional fossil fuel-based activities to clean economic models, significant capital investments are necessary, particularly at a time

when energy demand continues to grow (Razzaq *et al*., 2021). Despite their expansion, however, green financial markets remain a fragile segment, vulnerable to a range of risks, particularly those arising from climate change and its associated physical and transition impacts.

Thus, while green finance presents significant opportunities, its performance is intricately tied to several risk factors. The growing importance of these risks; both in terms of physical disruptions and regulatory changes, underscores the need for a deeper understanding of how they affect sustainable stock indices.

2.6 French sustainable market performance

Regarding the literature on France within this research subject, empirical evidence from the Banque de France highlights the presence of a "greenium",a yield discount for sovereign and corporate green bonds, suggesting that investors are willing to pay a premium for sustainability, even though the magnitude of this effect is time-varying (Banque de France, 2021). Similarly, institutional studies show that French investment funds continue to hold non-trivial exposures to transition risk, as portfolios remain partially invested in carbon-intensive sectors (Jourde and Koné, 2023). While these contributions provide important insights into bond pricing and systemic exposure, they focus primarily on fixed-income markets and macroprudential stability, offering limited guidance on the performance and diversification of sustainable equity indices. Given that France has pioneered dedicated ESG-focused stock indices, such as the CAC 40 ESG, the need for country-specific analysis is of interest.

Furthermore, despite the research advances made in the literature regarding this subject as mentioned in previous sections, much of its evidence remains mixed and continues to prioritize global or regional (EU) aggregates or U.S. markets, leaving limited attention to national sustainable indices such as those in France. Studies that explore the effect of global factors on France's sustainable market performance are rare despite the country's leadership in sustainable finance.Specifically, only a few papers analyze physical climate risk and transition risk separately for France, examining their effects on green financial assets, with green bonds as the primary focus.

To summarize the literature scope, the existing studies establish valuable foundations but leave several gaps unaddressed. First, most papers concentrate on global or regional aggregates (such as broad ESG indices or cross-country bond markets) rather than examining sustainable equity markets within specific national contexts (Lee *et al*., 2021). Second, empirical work rarely integrates multiple risk channels simultaneously: global volatility (VIX, OVX), geopolitical risk, oil price shocks, and physical versus transition climate risks are often studied separately. Third, while France has positioned itself as a global leader in sustainable finance through pioneering regulation and substantial green bond issuance (Agence France Trésor, 2023a, b), little is known about how its sustainable stock indices react across different market conditions. Addressing these gaps through quantile-based investigation would allow researchers to capture the asymmetric and nonlinear effects of multiple global and climate-related shocks, thereby enriching academic understanding and offering actionable insights for investors and policymakers seeking to bolster financial stability and resilience in the French green finance market.

3. Data

This study employs daily data from April 1, 2017, to December 28, 2023. This period is characterized by dynamic changes in climate legislation, financial investments, and the development of related products. From 2017 to 2023, there were significant shifts in green investments, influenced by the Paris Agreement, the COVID-19 pandemic, and subsequent green recovery plans. The 2015 Paris Climate Agreement catalyzed global momentum toward green investments, while the 2020 pandemic caused economic disruption, impacting stock

markets and accelerating discussions on sustainability and ESG investments. Post-pandemic, green recovery plans, including the European Green Deal and France's Reliance Plan, marked a critical phase for green stimulus. The 2022 energy crisis, sparked by the Russia-Ukraine conflict, also caused a structural shift in energy markets, particularly affecting renewable energy sectors. From 2015 to 2020, green investments gained global traction, while the 2020–2023 period highlighted how green markets responded to the pandemic and recovery efforts. Key regulatory shifts, like the EU Taxonomy for Sustainable Activities (2020) and France's 2019 Energy and Climate Law, further influenced investor behavior and the transition to a low-carbon economy.

As this paper aims to assess the impact of global environmental factors and global volatility factors on the performance of French sustainable stocks, we use the S&P France 40 Paris-Aligned Transition ESG Index (SPFRPAEP) as a proxy for sustainable stock performance in France. The SPFRPAEP is designed to align with the Paris-Aligned Benchmark (PAB) criteria, ensuring compatibility with a 1.5 °C global warming scenario. It tracks the 40 leading French companies committed to the climate goals outlined in the Paris Agreement, focusing on climate transition and decarbonization strategies while incorporating Environmental, Social, and Governance (ESG) factors to select and weight stocks based on sustainability performance (S&P Dow Jones Indices, 2025). The index adheres to a Paris-Aligned framework, which excludes high-carbon-emitting companies that fail to meet climate transition requirements. Unlike traditional green indices, which primarily focus on clean energy sectors, the SPFRPAEP takes a broader approach by encompassing companies from various industries that are actively transitioning toward sustainability, making it a comprehensive tool for assessing corporate sustainability and supporting climate-conscious investment strategies (S&P Dow Jones Indices, 2025). This study chooses a sustainable index over a green index because sustainable indices provide a broader and more holistic measure of sustainability. While green indices focus solely on environmental factors, sustainable indices integrate social and governance aspects, making them a more well-rounded measure of corporate sustainability. Additionally, sustainable indices account for corporate governance practices, which are essential for achieving long-term sustainability, whereas green indices often overlook governance and industry-wide efforts to reduce carbon emissions. By considering a wider scope of sustainability-related factors, sustainable indices offer better generalizability and a more insightful perspective for policymakers, institutional investors, and ethical investors who prioritize long-term sustainability beyond financial returns.

When it comes to global environment-related factors in our framework consist of three components: the performance of global green bonds, measured by the S&P Green Bond Index, and two climate-related risk indicators; the Transition Risk Index (TRI) and the Physical Risk Index (PRI) developed by Bua *et al*. (2024).

With respect to green bonds, it is important to note that treating them as a conventional "global financial risk factor" would not be conceptually rigorous, since they are financial assets in their own right. Their inclusion in this study is not intended to model them as a source of risk, but rather to capture their role as an alternative asset class with hedging and defensive properties, particularly under inflationary pressures and periods of market uncertainty. This interpretation aligns with the broader finance literature, where sovereign and corporate bond returns are often analyzed for their correlation with equity markets, serving as indicators of portfolio diversification, safe-haven behavior, or inflation-hedging capacity. Accordingly, the inclusion of green bond returns reflects their signal value: not as drivers of systemic financial risk, but as global contributors that embody defensive investor behavior, analogous to conventional bond–equity dynamics.

The other two components, the PRI and TRI, are derived using a text-based methodology that captures shifts in global climate risk narratives. Specifically, Bua *et al*. (2024) construct vocabularies of terms associated with physical risks (e.g. extreme weather events) and transition risks (e.g. policy changes, technological shifts) by processing authoritative scientific texts on climate change. These terms are converted into numerical vectors using the term

frequency–inverse document frequency (TF-IDF) method, which ranks words by their relevance. Daily news articles from Reuters are then analyzed with a cosine similarity approach to identify periods of heightened attention to these risks. The resulting PRI and TRI time series thus represent shocks in climate risk discourse, capturing unexpected spikes in global concern about physical and transition risks, respectively.

Regarding the global volatility factors, they also consist of three components: the Global Geopolitical Risk Index (G.GPR), the Oil Volatility Index (OVX), and the CBOE Volatility Index (VIX). The GPR measures geopolitical risk based on the frequency of words related to geopolitical tensions in leading global news platforms, focusing on multiple forms of political instability, including terror attacks, military threats, and war risks. Developed by Dario Caldara and Matteo Iacoviello, the GPR tracks geopolitical tensions using articles from 10 newspapers, monitoring events since 1900 and spiking during major crises such as the World Wars and 9/11. The index categorizes geopolitical events into eight groups and includes two subindices: Geopolitical Threats and Geopolitical Acts. While the GPR index begins in 1985, the Geopolitical Risk Historical Index extends back to 1900, with country-specific indices for advanced and emerging economies [1]. The OVX, or CBOE Crude Oil Volatility Index, is calculated by interpolating two time-weighted sums of option mid-quote values, incorporating both historical information and future expectations of oil prices, making it a better-suited proxy for reflecting oil market uncertainty (Lin and Su, 2020) [2]. The CBOE Volatility Index (VIX), widely recognized as a predictor of short-term volatility in U.S. stock markets, measures the implied volatility of the S&P 500 Index over the next 30 days. Known as the "investor fear index," the VIX has been strongly associated with market instability in the United States (Whaley, 2000) [3].

Table 1 presents the descriptive statistics for the series under study. The OVX exhibits the highest average value (40.33) and the largest standard deviation (21.27), indicating substantial volatility in oil market expectations. In contrast, G.GBR shows the lowest mean (−5.02E05) and standard deviation (0.0038), reflecting the relative stability of global bond returns. The average return of the French market is positive (0.0004), while both TRI and PRI indices display small negative means (−0.0025 and −0.0011, respectively).

In terms of distributional characteristics, all series demonstrate positive kurtosis, suggesting the presence of fat tails. The highest levels are observed in France Return (55.07) and OVX (44.51), indicating extreme movements in these markets. Skewness is mostly mild and negative for return-based series, except for OVX and G.GPR, which are positively skewed. The Jarque-Bera (JB) test strongly rejects the null hypothesis of normality for all variables, with exceptionally high values, especially in France Return and OVX. These results confirm that the distribution of financial and risk variables deviates from normality, suggesting the appropriateness of models that accommodate non-normal distributions such as quantile regression.

Table 1. Descriptive statistics

Variable	Mean	Std. dev	Max	Min	Skewness	Kurtosis	JB
France return	0.0004	0.0327	0.3599	−0.3638	−0.2943	55.0669	205720.4000
G.GBR	−0.0001	0.0038	0.0226	−0.0242	−0.0721	8.1712	2030.6290
OVX	40.3340	21.2744	325.1500	17.8600	5.3685	44.5113	139494.2000
VIX	19.2474	8.0045	82.6900	9.1400	2.3460	13.7152	10382.1900
TRI	−0.0025	0.0227	0.1143	−0.0814	0.3850	4.3382	180.8842
PRI	−0.0011	0.0221	0.1225	−0.0559	0.7347	4.5384	343.4264
G.GPR	116.4069	56.6830	540.8274	9.4915	2.1066	11.8706	7317.4300

Note(s): ***, **, and * significant at 1%, 5%, and 10%, respectively G.GBR refers to global green bonds, OVX refers to CBOE Crude Oil Volatility Index, VIX refers to CBOE Volatility Index, TRI refers to Transition Risk Index, PRI refers to Physical Risk Index, and G.GPR refers to Global Geopolitical Risk Index

Source(s): Author's own elaboration

To assess the stationarity of the variables, the augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests are applied, with results reported in Table 2. Both tests consistently reject the null hypothesis of a unit root across all series. These findings confirm that all variables are stationary in their current form.

4. Methodology

Following Wang *et al*. (2023), we analyze the effect of global financial factors (GFF), global volatility factors (GVF), and environmental factors (EF) on the returns of the French sustainable stock market using the following model:

$$R_t = \propto_0 + \sum_{i=1}^{N} \beta_i \, GFF_{it} + \sum_{j=1}^{M} \delta_j \, GVF_{jt} + \sum_{f=1}^{Q} \tau_f \, EF_{ft} + \varepsilon_t$$

where.

i, j. f represent the global financial factors, global volatility factors, and environmental factors, respectively.

β_i reflects the sensitivity of the French sustainable stock market index to global financial factors i.

δ_j reflects the sensitivity of the stock index to global volatility factors j.

TfT_f reflects the sensitivity of the stock index returns to environmental risk factors f.

The variables in our model are defined as follows.

R_t: French sustainable stock index returns at time t.

GFF_{it}: Global financial factors, such as G.GBR at time t.

GVF_{jt}: Global volatility factors, including VIX, OVX, and G.GPR at time t.

EF_{ft}: Environmental risk factors, including TRI and PRI at time t.

By taking into account three different types of global influences; global financial factors (GFF), global volatility factors (GVF), and environmental factors (EF), the model seeks to investigate the factors that influence sustainable stock market returns in France. Incorporating these three dimensions, the model offers a framework for determining whether global volatility shocks, financial linkages, or risk narratives related to climate change are amongst

Table 2. Unit root test

Variable	ADF	PP
France return	−22.8218 ***	−69.0827 ***
G.GBR	−36.0483 ***	−36.1984 ***
OVX	−4.2442***	−6.6533 ***
VIX	−4.5053 ***	−5.7769***
TRI	−11.5195 ***	−50.9718 ***
PRI	−12.9834***	−49.4217***
G.GPR	−8.0661***	−30.0947***

Note(s): ***, **, and * significant at 1%, 5%, and 10%, respectively G.GBR refers to global green bonds, OVX refers to CBOE Crude Oil Volatility Index, VIX refers to CBOE Volatility Index, TRI refers to Transition Risk Index, PRI refers to Physical Risk Index, and G.GPR refers to Global Geopolitical Risk Index

Source(s): Author's own elaboration

the main drivers of movements in the French sustainable stock market. This underscores the relative significance of global channels in influencing sustainable asset returns.

To estimate the effect of GFF, GVF, and EF, we first employ an Ordinary Least Squares (OLS) regression. However, financial data often contain outliers due to thick-tailed distributions, which can distort OLS estimates (Greene, 2020). Specifically, OLS is less robust when analyzing stock market data beyond the mean or at extreme values. To overcome this limitation, we apply the quantile regression model developed by Koenker and Bassett (1978). This approach is widely used to examine dependence structures and asymmetries in financial markets (Joo and Park, 2021; Essayem *et al*., 2024). Unlike OLS, quantile regression does not assume a specific distribution for Y|XY|X or its conditional variance.

The quantile regression model is specified as:

$$Q_y\left(\frac{\tau}{x}\right) = x'\beta(\tau)$$

Where $Q_y\left(\frac{\tau}{x}\right)$ denotes the conditional quantile function of Y.

We study the dynamics of the French sustainable stock market across three phases lower quantile level (0.1, 0.2, 0.3) that reflects the lowest changes in the French sustainable stock market, medium quantile level (0.4, 0.5, 0.6) that reflect the moderate changes in the French sustainable stock market, and upper quantile level (0.7, 0.8, 0.9) that reflects the highest changes in the French sustainable stock market. Using this framework, the model aims to determine whether global factors have symmetric or asymmetric effects on the market at different stages. This gives us a better understanding of the resilience/vulnerability of sustainable investments under various circumstances by enabling us to go beyond average relationships and instead emphasize how shocks and risk drivers affect the French sustainable stock market differently during downturns, normal periods, and peaks.

To verify the robustness of our results, we perform the Wald test to examine parameter heterogeneity across quantiles under the null hypothesis that quantile slope coefficients are identical. Furthermore, we re-estimate the model using an alternative proxy for the regional stock market to ensure consistency.

5. Results and discussion

Table 3 presents the results of both the OLS estimation and the quantile regression method. The OLS results show that green bond returns have a significant positive impact on the sustainable stock index in France. This suggests that rising yields in green bonds positively influence sustainable stock returns. However, OLS results reflect only the average relationship between stock returns and the explanatory variables, centered around the conditional mean.

In contrast, the quantile regression results provide a more detailed view across the distribution of stock returns. Green bond returns (GBR) exhibit a consistently positive impact across all quantiles, with a stronger influence during the normal phase of the market and the onset of bullish conditions. This indicates that increases in green bond returns are associated with higher sustainable stock index returns across different market states. Unlike traditional markets, where stock and bond returns often exhibit a dichotomous relationship, green finance shows a more unified performance pattern. However, this stronger connection could reduce diversification opportunities for investors holding both sustainable stocks and green bonds as risk-free hedging assets. This finding aligns with the insights of Fama and French, who noted that in the short term, stock and bond returns can fluctuate between positive and negative correlations depending on growth expectations (Pereira *et al*., 2024).

Regarding market volatility, the VIX index significantly impacts sustainable stock returns across most quantiles, except at Q6, Q7, and Q9. The negative impact is particularly persistent during bearish and normal markets, following a decreasing trend: it is strongest at the beginning of a bearish market and progressively weakens until reaching its lowest point

Table 3. Results table

Variable	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9	OLS
C	0.0047	0.0049	0.0032	0.0024	0.0021	0.0018	0.0019	0.0011	0.0012	0.0036
	(0.0097)	(0.0126)	(0.0221)	(0.0515)	(0.0274)	(0.1013)	(0.1441)	(0.4140)	(0.5944)	(0.1469)
BOND	1.3577***	1.3967***	1.3337***	1.4253***	1.4079***	1.5027****	1.5353***	1.4886***	1.3123***	1.7052***
RETURN	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0000)
VIX	−0.0007***	−0.0006***	−0.0004***	−0.0003***	−0.0001***	−7.1E05	6.0E05	0.0001***	0.0002	−0.0002
	(0.0000)	(0.0000)	(0.0000)	(0.0000)	(0.0017)	(0.2933)	(0.3772)	(0.0047)	(0.2184)	(0.1267)
OVX	−6.6E05	−1.9E05	4.2E05	8.5E05***	7.0E05***	8.4E05***	7.1E05**	0.0001***	0.0001	3.4E−05
	(0.3454)	(0.7270)	(0.4604)	(0.0067)	(0.0008)	(0.0003)	(0.0226)	(0.0015)	(0.2185)	(0.5165)
GGPR	−7.5E06	−6.3E06	−5.1E06	−6.7E06	−4.6E06	−5.7E06	−3.8E06	4.6E07	1.3E05	−3.8E−06
	(0.4896)	(0.5073)	(0.4321)	(0.2809)	(0.3548)	(0.3103)	(0.4959)	(0.9555)	(0.4300)	(0.7725)
TRI	0.0219	0.0095	0.0207	0.0132	0.0039	−0.0154	−0.0266**	−0.0333**	−0.0479***	0.0058
	(0.5141)	(0.6302)	(0.1126)	(0.3294)	(0.7784)	(0.3166)	(0.0348)	(0.0136)	(0.0087)	(0.8722)
PRI	−0.0423*	−0.0168	−0.0242*	−0.0122	−0.0125	−0.0047	−0.0080	0.0050	−0.0077	−0.0450
	(0.0651)	(0.3315)	(0.0766)	(0.3984)	(0.3966)	(0.7423)	(0.5714)	(0.7589)	(0.6822)	(0.2334)

Note(s): ***, **, and * significant at 1%, 5%, and 10%, respectively

Source(s): Author's own elaboration

around Q5. This pattern supports previous findings that financial instability strongly negatively affects sustainable stock markets during periods of economic turbulence (Gaies and Chaâbane, 2024). At higher quantiles, particularly in bullish markets, the VIX's effect switches to a positive relationship (notably at Q8), suggesting that during periods of high market optimism, financial instability might enhance the attractiveness of green stocks. This particular case can be explained by investor sentiment and reallocation dynamics. During a bullish market, investors may interpret moderate volatility as a signal for re-pricing or rotation, reallocating capital into ESG stocks perceived as resilient or ethical. In this context, volatility can act as a catalyst for repositioning rather than pure retreat. Particularly, it reflects a feedback loop where instability leads investors to perceive green stocks as safer or more ethical alternatives, driving increased investment and reinforcing performance (Gaies and Chaâbane, 2024). Empirical evidence further support supports this view, Negi *et al*., (2025) shows that VIX effects on ESG indices vary across quantiles, with positive signs at upper levels, while Rizvi *et al*. (2022) find that ethical and green assets often show relative strength or attract flows during periods of uncertainty.

Similarly, the OVX index shows a positive impact on sustainable stock market performance during normal (Q4, Q5, Q6) and bullish (Q7, Q8) market conditions. This indicates that volatility in traditional energy markets, particularly oil, boosts investment in sustainable assets, as investors seek greener alternatives when conventional, polluting assets become riskier (Shahbaz *et al*., 2021). During bearish markets, however, the impact of OVX is insignificant, supporting the "decoupling hypothesis," which suggests that clean energy stocks become less correlated with extreme fluctuations in oil markets (Usman, 2023).

At the risk level, the global geopolitical risk (GPR) index shows no significant impact on sustainable stock indices, confirming the resilience of the French market to both global and local geopolitical shocks. However, climate-related risks do significantly influence performance, depending on the type of risk. Transition risks negatively affect sustainable stock returns particularly during bullish markets. In periods of strong market performance, capital tends to flow toward sectors offering the highest short-term returns, such as energy, industrials, and technology; often benefiting fossil fuel companies at the expense of ESG-aligned firms (IEA, 2022; BlackRock, 2020). Furthermore, companies transitioning toward greener operations often face short-term financial pressures, including regulatory uncertainty and cost volatility, making them less attractive to momentum-driven investors (TCFD, 2017; Barberis *et al*., 2005). Also the inconsistency of the sign and significance of the effect of both risks across quantiles can be because asset prices underestimate climate risks rather than overestimate them (Stroebel and Wurgler, 2021).

In addition, physical risks related to climate change, such as extreme weather events and environmental degradation, exert a negative impact during bearish market conditions, particularly at the lowest quantiles. In such times, risk-averse investors tend to move away from assets exposed to climate volatility, despite the long-term resilience goals of ESG-oriented companies (TCFD, 2017). This risk-off behavior exacerbates the short-term underperformance of sustainable indices relative to traditional markets, amplifying losses during downturns.

Summarizing the discussion, we conclude that the findings from the quantile regression analysis underscore the asymmetric impact of global financial and climate-related factors on the performance of the French sustainable stock index (Please check Table 4 for results summary). While green bond returns exert a consistently positive effect across the return distribution, their influence intensifies in normal and moderately bullish market conditions, highlighting a procyclical behavior that aligns sustainable equities more closely with green fixed-income assets and thus potentially limits diversification benefits. Volatility measures, particularly the VIX, exhibit a varying impact: they significantly depress returns during bearish and normal phases but shift to a positive influence in upper quantiles, suggesting that investor sentiment toward sustainable assets becomes more favorable under optimistic market conditions. The OVX shows a similarly state-dependent relationship, positively affecting

Table 4. Results summary

Global factor	Quantile regression insights	Market phase sensitivity
Green Bond Returns	Consistently positive across all quantiles; strongest during normal and early bullish phases	Suggests unified performance of green stocks and bonds, reducing diversification potential during moderate/bullish trends
VIX	Strongly negative during bearish/normal markets (Q1–Q5); switches to positive in bullish quantiles (notably Q8)	Reflects fear-driven flight from ESG in downturns; possible "safe-haven" appeal of green stocks in optimistic markets
OVX	Positive during normal (Q4–Q6) and bullish markets (Q7–Q8); insignificant during bearish phases	Supports the "green hedge" hypothesis—oil market instability pushes capital into sustainable stocks during stable times
Global Geopolitical Risk	Insignificant across all quantiles	Indicates France's ESG index resilience to geopolitical tensions
Climate Transition Risks	Negative impact, especially during bullish phases	Bull markets favor high-return sectors (e.g. tech, energy); ESG firms face short-term transition costs
Physical Climate Risks	Strong negative effect during bearish markets (lowest quantiles)	Investors flee climate-exposed assets in downturns, reinforcing ESG underperformance

Source(s): Author's own elaboration

sustainable stock returns during stable and bullish periods while remaining insignificant during downturns, consistent with the hypothesis that clean investments serve as substitutes when fossil fuel markets become unstable. In contrast, global GPR exerts no meaningful influence across quantiles, reflecting the French ESG market's relative insulation from political shocks. However, climate-related risks display nuanced asymmetries: transition risks dampen ESG performance particularly during bullish conditions, as investors prioritize short-term gains in high-growth, carbon-intensive sectors; meanwhile, physical climate risks weigh most heavily during bearish markets, when risk-averse behavior prompts a retreat from climate-exposed assets. Collectively, these asymmetric effects highlight the importance of distribution-sensitive approaches in evaluating sustainable asset performance and emphasize that market phase, investor sentiment, and the nature of the risk factor critically shape ESG return dynamics.

6. Robustness check

To assess the robustness of our findings, we use a Wald test to account for quantile slopes. The results of the Wald test are presented in Table 5, Table 6 and Table 7 [4]. These tables display the Wald test outcomes for quantile slopes at the 0.1, 0.5, and 0.9 quantiles, where the null hypothesis assumes identical quantile slope coefficients. Table 5 shows that at 0.1 quantile level, the Wald test rejects the null hypothesis for the return of green bonds at Q9. Similarly, at the 0.5 quantile level and for the 0.9 quantile level, the null hypothesis is rejected at Q7, all of which indicate that the effect of global green bond returns varies across different quantiles, suggesting that these returns have heterogeneous impacts on the sustainable stock market index in France.

Table 6 shows that at the 0.1 quantile level, the Wald test rejects the null hypothesis for vix index at Q3, Q5, Q6, and Q7. Similarly, at the 0.5 and 0.9 quantile levels, the null hypothesis is rejected for almost all quantiles. This provides clear evidence that the impact of the global fear index varies across quantiles, indicating asymmetric effects on the sustainable stock market index in France.

Table 5. Wald test results (Green bonds)

G.GBR								
At 1st	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
Quantile	0.001	−0.0086	−0.0237	−0.0668	0.0074	−0.0714	0.0051	0.1975**
	0.09867	−0.9339	−0.7288	−0.3106	−0.9071	−0.2703	−0.9334	−0.0145
At 5th	Q1	Q2	Q3	Q4	Q6	Q7	Q8	Q9
Quantile	−0.0086	−0.0237	−0.0668	0.0479	−0.0405	−0.0714	0.0051	0.1975**
	0.9339	0.7288	−0.3106	−0.3077	−0.3841	−0.2703	−0.9334	−0.0145
At 9th	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
Quantile	−0.0086	−0.0237	−0.0668	0.0074	−0.0714	0.0051	0.1975**	0.0048
	0.9339	−0.7288	−0.3106	−0.9071	−0.2703	−0.9334	−0.0145	−0.9167
At 5th	Q1	Q2	Q3	Q4	Q6	Q7	Q8	Q9
Quantile	−0.0086	−0.0237	−0.0668	0.0479	−0.0405	−0.0714	0.0051	0.1975**
	0.9339	0.7288	−0.3106	−0.3077	−0.3841	−0.2703	−0.9334	−0.0145
At 9th	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
Quantile	−0.0086	−0.0237	−0.0668	0.0074	−0.0714	0.0051	0.1975**	0.0048
	0.9339	−0.7288	−0.3106	−0.9071	−0.2703	−0.9334	−0.0145	−0.9167

Source(s): Author's own elaboration

Table 7 shows that at the 0.1 and 0.5 quantile levels, the Wald test rejects the null hypothesis for the TRI index at Q6 and Q7. At the 0.9 quantile level, the null hypothesis is also rejected at Q4 and Q5. These findings provide evidence that environmental risk impacts the sustainable stock market index in France asymmetrically across quantiles.

The findings indicate that the estimated coefficients are not constant, meaning that the structure of dependence with respect to the coefficients changes. This supports the robustness of the main results presented in Table 3.

7. Conclusion

This study highlights the complex dynamics between green bond returns, financial market volatility, and climate-related risks in shaping the performance of sustainable stock indices. The results reveal that green bonds consistently support sustainable stock returns across market conditions, though this reduces potential diversification benefits for green investors. Financial market volatility, measured by VIX and OVX, exerts varying influences depending on market phases, with signs of a positive feedback loop during bullish periods. While geopolitical risks appear to have limited impact, climate-related risks, particularly transition and physical risks, significantly affect sustainable stocks, underscoring their vulnerability during both bullish and bearish markets. Overall, these findings emphasize the growing integration of green finance within broader market dynamics and the need for investors to account for both financial and environmental risks when constructing sustainable portfolios.

From a policy perspective, these results are highly relevant for both the European Union and France. At the EU level, the findings reinforce the rationale for the Sustainable Finance Disclosure Regulation (SFDR) and the EU Taxonomy for sustainable activities, both of which aim to improve transparency and risk integration in green investments. At the French level, the evidence points to the need for a stronger alignment of domestic financial regulation with national priorities set out in the Energy Transition Law and the France 2030 Strategy. While EU initiatives provide a common framework, France's unique reliance on nuclear energy, its ambition to position Paris as a leading hub for sustainable finance, and Financial Markets Authority (AMF)'s active role in enforcing ESG disclosures create distinct policy challenges and opportunities. Specifically, French authorities should broaden the range of sustainable financial products to mitigate the reduced diversification potential of green bonds and develop stabilization mechanisms to protect sustainable investments from volatility spillovers.

Table 6. Wald test results (VIX)

VIX								
At 1st Quantile	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
	3.6E−05	−0.0003***	−5.0E−05	−0.0001**	−0.0001***	−0.0001**	−0.0001	−0.0001
	0.6885	0.0001	0.4651	0.0130	0.0042	0.0204	0.1133	0.5150
At 5th Quantile	Q1	Q2	Q3	Q4	Q6	Q7	Q8	Q9
	−0.0003***	−5.E−05	−0.0001**	−4.6E−05	−0.0001***	−0.0001**	−0.0001	−3.68E−06
	0.0001	0.4651	0.0130	0.2598	0.0021	0.0204	0.1133	0.7257
At 9th Quantile	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
	−0.0003***	−5.0E−05	−0.0001**	−0.0001***	−0.0001***	−0.0001***	−0.0001	−3.6E−06
	0.0001	0.4651	0.0130	0.0042	0.0024	0.0204	0.1133	0.9619

Source(s): Author's own elaboration

Table 7. Wald test results (TRI)

TRI								
At 1st Quantile	Q2	Q3	Q4	Q5	Q6	Q7	Q8	Q9
	−0.0066	0.0186	−0.0085	0.0111	0.0163*	0.0196**	5.9E−06	0.0085
	0.6219	0.3329	0.4850	0.2004	0.0773	0.0394	0.9995	0.5852
At 5th	Q1	Q2	Q3	Q4	Q6	Q7	Q8	Q9
Quantile	0.0186	−0.0085	0.0111	0.0033	0.0130*	0.0196**	5.9E−06	0.0085
	0.3329	0.4850	0.2004	0.5955	0.0609	0.0394	0.9995	0.5852
At 9th	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
Quantile	0.0186	−0.0085	0.0111	0.0163*	0.0196**	5.9E−06	0.0085	0.0106
	0.3329	0.4850	0.2004	0.0773	0.0394	0.9995	0.5852	0.1607

Source(s): Author's own elaboration

Moreover, given that transition and physical climate risks have a significant negative impact on sustainable stocks, it is crucial to mandate stronger climate-related financial disclosures beyond the EU minimum requirements. Such measures would allow for better pricing of these risks and contribute to safeguarding investors' financial well-being.

This paper has several limitations. First, the study was constrained by the starting date of the time series data, which may limit the broader generalizability of the results. Second, the existing literature on the impact of climate-related risks on green and sustainable financial asset performance remains scarce, which restricted the depth of our discussion regarding transition and physical risks (TRI and PRI). Lastly, for future research, we recommend a deeper exploration of the French context, given France's leadership role in sustainable finance. Studies should adopt a country-specific approach rather than grouping France within broader EU or G7 market analyses, to better isolate its unique dynamics. Further, future research should also closely examine the effects of climate-related risks on the volatility and performance of green and sustainable financial assets.

Notes

1. For further details about the global geopolitical risk Methodology, please see: https://www.matteoiacoviello.com/gpr.htm
2. For further details about Cboe Crude Oil ETF Volatility Index, please see: https://www.cboe.com/us/indices/dashboard/ovx/
3. For further details about the CBOE Volatility Index methodology, please see: https://www.cboe.com/tradable_products/vix/
4. To save space, we only show the results for quantiles 0.1, 0.5 and to 0.9. Full Wald test results are available upon request from the corresponding author.

References

Agence France Trésor (2023a), "France's commitment to green finance: progress and prospects", Ministère de l'Économie, des Finances et de la Souveraineté industrielle et numérique.

Agence France Trésor (2023b), "Green OAT", available at: https://www.aft.gouv.fr/en/oat-green

Alqahtani, A. and Klein, T. (2021), "Oil price changes, uncertainty, and geopolitical risks: on the resilience of GCC countries to global tensions", *Energy*, Vol. 236, 121541, doi: 10.1016/j.energy.2021.121541.

Auer, B.R. and Schuhmacher, F. (2016), "Do socially (ir)responsible investments pay? New evidence from international ESG data", *The Quarterly Review of Economics and Finance*, Vol. 59, pp. 51-62, doi: 10.1016/j.qref.2015.07.002.

Balcilar, M., Demirer, R. and Gupta, R. (2018), "Geopolitical risks and stock market dynamics of the BRICS", *Economic Systems*, Vol. 42 No. 2, pp. 295-306, doi: 10.1016/j.ecosys.2017.05.008.

Bansal, R., Kiku, D. and Ochoa, M. (2016), "Climate change and growth risks", NBER Working Paper No. 23009. National Bureau of Economic Research.

Barberis, N., Shleifer, A. and Wurgler, J. (2005), "Comovement", *Journal of Financial Economics*, Vol. 75 No. 2, pp. 283-317, doi: 10.1016/j.jfineco.2004.04.003.

Battiston, S., Mandel, A., Monasterolo, I., Schütze, F. and Visentin, G. (2017), "A climate stress-test of the financial system", *Nature Climate Change*, Vol. 7 No. 4, pp. 283-288, doi: 10.1038/nclimate3255.

Banque de France (2021), "Climate-related risks and financial stability".

Bauer, R., Ruof, T. and Smeets, P. (2022), "Get real! Individuals prefer more sustainable investments", *Review of Financial Studies*, Vol. 35 No. 3, pp. 1230-1270.

Bianchi, D. (2020), "Cryptocurrencies as an asset class? An empirical assessment", *Journal of Alternative Investments*, Vol. 23 No. 2, pp. 162-179, doi: 10.3905/jai.2020.1.105.

BlackRock (2020), "Sustainability: the future of investing".

Bolton, P. and Kacperczyk, M. (2021), "Do investors care about carbon risk?", *Journal of Financial Economics*, Vol. 142 No. 2, pp. 517-549, doi: 10.1016/j.jfineco.2021.05.008.

Borghesi, S., Castellini, M., Comincioli, N., Donadelli, M., Gufler, I. and Vergalli, S. (2022), "European green policy announcements and sectoral stock returns", *Energy Policy*, Vol. 166, 113004, doi: 10.1016/j.enpol.2022.113004.

Bua, G., Kapp, D., Ramella, F. and Rognone, L. (2024), "Transition versus physical climate risk pricing in European financial markets: a text-based approach", *The European Journal of Finance*, Vol. 30 No. 17, pp. 2076-2110, doi: 10.1080/1351847X.2024.2355103.

Caldara, D. and Iacoviello, M. (2022), "Measuring geopolitical risk", *The American Economic Review*, Vol. 112 No. 4, pp. 1194-1225, doi: 10.1257/aer.20190374.

Carney, M. (2015), *Breaking the Tragedy of the Horizon—Climate Change and Financial Stability*, Speech at Lloyd's of London. The Guardian, London.

Climate Bonds Initiative (2020), "Green bonds: the state of the market 2019".

Dutta, A., Bouri, E., Das, D. and Roubaud, D. (2020), "Assessment and optimization of clean energy equity risks and commodity price volatility indexes: implications for sustainability", *Journal of Cleaner Production*, Vol. 243, 118669, doi: 10.1016/j.jclepro.2019.118669.

Ehlers, T. and Packer, F. (2017), "Green bond finance and certification", *BIS Quarterly Review*, September 2017, pp. 89-104.

Engle, R.F., Giglio, S., Kelly, B., Lee, H. and Stroebel, J. (2020), "Hedging climate change news", *Review of Financial Studies*, Vol. 33 No. 3, pp. 1184-1216, doi: 10.1093/rfs/hhz072.

Essayem, A., Gormus, S., Guven, M., Erdal, F. and Uygun, U. (2024), "The global risk trinity of hydrocarbon economies: evidence from the method of moments quantile regression", *Energy Reports*, Vol. 12, pp. 3412-3421, doi: 10.1016/j.egyr.2024.09.022.

Fernández-Rodríguez, F., Gómez-Puig, M. and Sosvilla-Rivero, S. (2016), "Using connectedness analysis to assess financial stress transmission in EMU sovereign bond market volatility", *Journal of International Financial Markets, Institutions and Money*, Vol. 43, pp. 126-145, doi: 10.1016/j.intfin.2016.04.005.

Flammer, C. (2020), "Green bonds: effectiveness and implications for public policy", *Environmental and Energy Policy and the Economy*, Vol. 1, pp. 95-128, doi: 10.1086/706794.

Flammer, C. (2021), "Corporate green bonds", *Journal of Financial Economics*, Vol. 142 No. 2, pp. 499-516, doi: 10.1016/j.jfineco.2021.01.010.

Flouros, F., Pistikou, V. and Plakandaras, V. (2022), "Geopolitical risk as a determinant of renewable energy investments", *Energies*, Vol. 15 No. 4, p. 1498, doi: 10.3390/en15041498.

Gaies, B. and Chaâbane, N. (2024), "The dance of dependence: a macro-perspective on financial instability and its complex influence on the Euro-American green markets", *Journal of Economic Studies*, Vol. 51 No. 3, pp. 546-568, doi: 10.1108/jes-03-2023-0158.

Gavrilakis, N. and Floros, C. (2024), "Volatility and herding bias on ESG leaders' portfolios performance", *Journal of Risk and Financial Management*, Vol. 17 No. 2, p. 77, doi: 10.3390/jrfm17020077.

Giglio, S., Kelly, B. and Stroebel, J. (2021), "Climate finance", *Annual Review of Financial Economics*, Vol. 13, pp. 15-36.

Greene, W.H. (2020), *Econometric Analysis*, 9th ed., Pearson Education.

Iannone, B., Duttilo, P. and Gattone, S.A. (2025), "Evaluating the resilience of ESG investments in European markets during turmoil periods", *Corporate Social Responsibility and Environmental Management*, Vol. 32 No. 4, pp. 5006-5020, doi: 10.1002/csr.3225.

International Capital Market Association (ICMA) (2021), "Green bond principles", available at: https://www.icmagroup.org/sustainable-finance/the-principles-guidelines-and-handbooks/green-bond-principles-gbp/

International Energy Agency (IEA) (2022), "World energy outlook 2022", available at: https://www.iea.org/reports/world-energy-outlook-2022

Joo, Y.C. and Park, S.Y. (2021), "The impact of oil price volatility on stock markets: evidences from oil-importing countries", *Energy Economics*, Vol. 101, 105413.

Jourde, T. and Kone, K. (2023), "The exposure of French investment funds to transition climate risks [L'exposition des fonds d'investissement français aux risques climatiques de transition]", *Bulletin de la Banque de France*, 248/7, pp. 1-14.

Klusak, P., Agarwala, M., Burke, M., Kraemer, M. and Mohaddes, K. (2023), "Rising temperatures, falling ratings: the effect of climate change on sovereign creditworthiness", *Management Science*, Vol. 69 No. 12, pp. 7468-7491, doi: 10.1287/mnsc.2023.4869.

Kocaarslan, B. and Soytas, U. (2019), "Asymmetric pass-through between oil prices and clean energy stock prices: new evidence from a nonlinear ARDL approach", *Energy Reports*, Vol. 5, pp. 117-125, doi: 10.1016/j.egyr.2019.01.002.

Koenker, R. and Bassett, G., Jr. (1978), "Regression quantiles", *Econometrica: Journal of the Econometric Society*, pp. 33-50.

Krueger, P., Sautner, Z. and Starks, L.T. (2020), "The importance of climate risks for institutional investors", *Review of Financial Studies*, Vol. 33 No. 3, pp. 1067-1111, doi: 10.1093/rfs/hhz137.

Kumar, S., Managi, S. and Matsuda, A. (2012), "Stock prices of clean energy firms, oil and carbon markets: a vector autoregressive analysis", *Energy Economics*, Vol. 34 No. 1, pp. 215-226, doi: 10.1016/j.eneco.2011.03.002.

Lee, C.C., Lee, C.C. and Li, Y.Y. (2021), "Oil price shocks, geopolitical risks, and green bond market dynamics", *The North American Journal of Economics and Finance*, Vol. 55, 101309.

Lin, B. and Su, T. (2020), "Mapping the oil price-stock market nexus researches: a scientometric review", *International Review of Economics and Finance*, Vol. 67, pp. 133-147, doi: 10.1016/j.iref.2020.01.007.

Managi, S. and Okimoto, T. (2013), "Does the price of oil interact with clean energy prices in the stock market?", *Japan and the World Economy*, Vol. 27, pp. 1-9, 10.1016/j.japwor.2013.03.003.

Negi, P., Kushwah, S.V., Jaiswal, A. and Rekunenko, I. (2025), "Investor sentiment, market volatility, and ESG Index dynamics: an empirical analysis", *Cogent Economics and Finance*, Vol. 13 No. 1, 2526721, doi: 10.1080/23322039.2025.2526721.

Öcal, H. and Kamil, A.A. (2021), "The impact of risk indicators on sustainability (ESG) and broad-based indices: an empirical analysis from Germany, France, Indonesia and Turkey", *International Journal of Sustainable Economy*, Vol. 13 No. 1, pp. 18-54, doi: 10.1504/ijse.2021.113319.

Pereira, M., Gomes, L., Maldonado, I. and Pereira, C. (2024), "Impact of green bond issues on Euronext firms' stock abnormal returns", *Journal of Infrastructure, Policy and Development*, Vol. 8 No. 10, p. 8274, doi: 10.24294/jipd.v8i10.8274.

Qin, M., Zhang, X. and Su, C.W. (2020), "Does geopolitical risk matter for stock returns? Evidence from BRICS countries", *Finance Research Letters*, Vol. 33, 101210, doi: 10.1016/j.frl.2019.06.005ScienceDirect.

Razzaq, A., Sharif, A., Aziz, B., Irfan, M. and Jermsittiparsert, K. (2021), "Asymmetric link between environmental taxation and environmental quality in the context of the green economy: evidence from developed economies", *Environmental Science and Pollution Research*, Vol. 28, pp. 16008-16028.

Rizvi, S.K.A., Naqvi, B. and Mirza, N. (2022), "Is green investment different from grey? Return and volatility spillovers between green and grey energy ETFs", *Annals of Operations Research*, Vol. 313 No. 1, pp. 495-524, doi: 10.1007/s10479-021-04367-8.

S&P Dow Jones Indices (2025), "S&P France 40 paris-aligned transition ESG index methodology".

Sadat, I. and Gormus, S. (2025), "Divergent impacts of financial factors on Islamic vs conventional stock markets: insights from advanced countries using MM-QR", *Journal of Capital Markets Studies*, Vol. 9 No. 1, pp. 6-27, doi: 10.1108/jcms-06-2024-0030.

Sadorsky, P. (2008), "Assessing the impact of oil prices on firms of different sizes: its tough being in the middle", *Energy Policy*, Vol. 36 No. 10, pp. 3854-3861, doi: 10.1016/j.enpol.2008.07.019.

Shahbaz, M., Trabelsi, N., Tiwari, A.K., Abakah, E.J.A. and Jiao, Z. (2021), "Relationship between green investments, energy markets, and stock markets in the aftermath of the global financial crisis", *Energy Economics*, Vol. 104, 105655.

Sohag, K., Hammoudeh, S., Elsayed, A.H. and Mariev, O. (2022), "Do geopolitical events transmit opportunity or threat to green markets? Decomposed measures of geopolitical risks", *Energy Economics*, Vol. 111, 106068, doi: 10.1016/j.eneco.2022.106068ResearchGate+1ScienceDirect+1.

Stroebel, J. and Wurgler, J. (2021), "What do you think about climate finance?", *Journal of Financial Economics*, Vol. 142 No. 2, pp. 487-498, doi: 10.1016/j.jfineco.2021.08.004.

Sweidan, O.D. (2021), "Is the geopolitical risk an incentive or obstacle to renewable energy deployment? Evidence from a panel analysis", *Renewable Energy*, Vol. 178, pp. 377-384, doi: 10.1016/j.renene.2021.06.089.

Task Force on Climate-related Financial Disclosures (TCFD) (2017), "Final report: recommendations of the task force on climate-related financial disclosures", *Financial Stability Board*, available at: https://www.fsb.org/2017/06/recommendations-of-the-task-force-on-climate-related-financial-disclosures-2/

United Nations (2015), "Paris agreement", available at: https://unfccc.int/process-and-meetings/the-paris-agreement/the-paris-agreement

Usman, M. (2023), "A stochastic dominance analysis of conventional and clean energy stocks during different oil market conditions", *Empirical Economics*, Vol. 65 No. 2, pp. 875-897, doi: 10.1007/s00181-023-02359-0.

Wang, K.H., Wang, Z.S., Yunis, M. and Kchouri, B. (2023), "Spillovers and connectedness among climate policy uncertainty, energy, green bond and carbon markets: a global perspective", *Energy Economics*, Vol. 128, 107170, doi: 10.1016/j.eneco.2023.107170.

Whaley, R.E. (2000), "The investor fear gauge", *Journal of Portfolio Management*, Vol. 26 No. 3, pp. 12-17, doi: 10.3905/jpm.2000.319728.

World Bank (2021), "France: green bond issuance", available at: https://www.worldbank.org/en/news/feature/2021/02/01/france-green-bond-issuance

Zhang, X., Li, Y. and Wang, J. (2020), "The impact of green finance on renewable energy invesment: evidence from China", *Journal of Cleaner Production*, Vol. 256, pp. 120-130.

Zhang, C., Cheng, X. and Ma, Y. (2022), "Research on the impact of green finance policy on regional green innovation—based on evidence from the pilot zones for green finance reform and innovation", *Frontiers in Environmental Science*, Vol. 10, 896661, doi: 10.3389/fenvs.2022.896661.

Zhang, D., Chen, X.H., Lau, C.K.M. and Cai, Y. (2023), "The causal relationship between green finance and geopolitical risk: implications for environmental management", *Journal of Environmental Management*, Vol. 327, 116949, doi: 10.1016/j.jenvman.2022.116949.

Further reading

Balli, F. and Basher, S.A. (2022), "Geopolitical risk and the dynamics of green investments", *Energy Economics*, Vol. 104, 105661.

European Commission (2020), "EU taxonomy for sustainable activities", available at: https://ec.europa.eu/info/business-economy-euro/banking-and-finance/sustainable-finance/eu-taxonomy-sustainable-activities_en

European Commission (2021), "The European green deal", available at: https://ec.europa.eu/clima/policies/eu-climate-action_en

Fama, E.F. and French, K.R. (1993), "Common risk factors in the returns on stocks and bonds", *Journal of Financial Economics*, Vol. 33 No. 1, pp. 3-56, doi: 10.1016/0304-405X(93)90023-5.

Français, G. (2020), "France Relance Plan: a €100 billion investment in the future", available at: https://www.gouvernement.fr/en/france-relance

Ministère de la Transition Écologique (2019), "Loi énergie-climat 2019", available at: https://www.ecologie.gouv.fr/loi-energie-climat

Corresponding author
Amal Essayem can be contacted at: amal.essayem@marmara.edu.tr