Research article

Green bond market performance: Does investor sentiment contagion matter?

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Abstract: This study identifies the dynamics of sentiment contagion between individual and institutional investors in the context of green bond markets across China, Japan, the United States, and the European Union (EU), covering the period from 3 January 2022 to 31 December 2024. Applying a time-varying parameter vector autoregression model, we construct sentiment contagion indicators to capture the evolving interdependencies in the sentiment of the two investor groups. Subsequently, we investigate the impact of these contagion effects on the performance of domestic and cross-border green bond markets by applying exponential general autoregressive conditional heteroscedasticity and quantile-on-quantile regression techniques. Our empirical results reveal consistently high levels of sentiment contagion, with particularly pronounced effects observed in Japan and the EU. The findings underscore the crucial role of sentiment spillovers in shaping green bond markets' performance, although the magnitude and direction of these effects vary across countries and quantiles. Our research findings contribute to the growing literature on sustainable and behavioral finance. It also offers valuable policy implications and investment strategies to green bond regulators and investors across countries.

1. Introduction

Investor sentiment is known to be contagious across various investor segments, including between domestic and foreign investors (Baker et al., 2012; Hudson & Green, 2015; Tsai, 2017) and across industries (Gong et al., 2022; Todd & Shuming, 2017; Yang & Xiong, 2024; Zhou et al., 2023). Nevertheless, the question of whether a sentiment contagion can be seen between different investor groups, namely individuals and institutions, has received less attention. It is widely acknowledged that these investor groups differ significantly in size, sophistication, and trading behavior (Griffin et al., 2003; Lakonishok & Edwin, 1990; Schmeling, 2007). Institutional investors tend to be contrarian (Griffin et al., 2003), driven by two key factors. First, they possess superior access to information, greater resources, and more time for in-depth analysis (Gao et al., 2021; Nofsinger & Sias, 1999). Second, they are generally more sophisticated and less prone to misestimating return variances (Schmeling, 2007; Wang, 2018). Consequently, existing research recognizes the distinction between institutional and individual investor sentiment, with the former often viewed as more rational (Verma & Verma, 2008). Specifically, institutional sentiment is frequently associated with "smart money", while individual sentiment is linked to "noise trader risk", and they rely on each other's sentiment to form expectations (Schmeling, 2007). This leads us to our first research question: Is sentiment contagious between individual and institutional investors?

Whether and how investor sentiment impacts green bonds has garnered increasing attention in recent literature. Early studies such as Pham & Huynh (2020); Piñeiro-Chousa et al. (2021, 2022) were among the first to explore this relationship, documenting sentiment's positive and significant influence on green bond returns. These findings have opened a research avenue examining the broader effects of investor sentiment on the performance of the green bond market, including its impact on returns (Pham & Cepni, 2022; Wu & Liu, 2023), volatility (Bouteska et al., 2024; Gao et al., 2023; Uckun-Ozkan, 2024), premiums (Fu et al., 2024), and spillovers (Le et al., 2025; Man et al., 2024). A review of the related literature also highlights the significance of general sentiment contagion in conventional asset pricing. However, it rarely connects the sentiment dynamics between individual and institutional investors with green bonds. Thus, a critical gap remains regarding whether these findings hold regarding sentiment contagion between individual and institutional investors. This prompts our second research question: How does sentiment contagion between individual and institutional investors influence green bond markets' performance?

Due to shifts in hedging demand (Dean et al., 2010; Pham, 2021) and increasing capital flow liberalization, investors are increasingly constructing international portfolios. This implies that investors from one country may actively participate in foreign markets (Le et al., 2025). Suppose that investor sentiment contagion plays a role in domestic markets. In that case, it is pertinent to ask whether this influence extends to the foreign markets where these investors hold assets, particularly in leading international markets. The strategy of international diversification among individual and institutional investors leads us to our third research question: To what extent does investor sentiment contagion affect the performance of foreign green bond markets?

To address these questions, our study considers four major international green bond markets, namely China, Japan, the US, and the European Union (EU), from 3 January 2022 to 31 December 2024. The research proceeds in three stages. First, we utilize the individual and institutional sentiment proxies

provided by Sentix GmbH to compute a sentiment contagion index for each market. Second, we use these indicators as explanatory variables to assess their influence on domestic green bonds' performance. Third, we examine whether this contagion from one country has a measurable impact on the performance of foreign green bond markets.

Our research makes several novel contributions to the literature on sustainable and behavioral finance. First, while existing studies on green bonds have concentrated considerably on issuer-side features, we shift attention to the investor side by explicitly examining investor sentiment as a key determinant of green bond markets' performance. This perspective is critical, given the currently supply-driven situation in green bond markets and the persistent imbalances between supply and demand. Second, we extend the investor sentiment literature that documents a transmission between the sentiment of individual and institutional investors by quantifying and constructing a sentiment contagion index between them. Third, although sentiment contagion has been widely studied in conventional financial markets, particularly in stock markets, its role in sustainable debt markets, notably green bond markets, remains unexplored. Thus, we bridge this gap by incorporating these dynamics into the performance of green bond markets to provide comprehensive empirical evidence on how sentiment contagion between investor groups affects the returns on green bonds. Fourth, this study goes beyond a purely domestic focus by incorporating both local and foreign green bond markets, thereby offering new insights into the cross-border transmission of sentiment in global sustainable finance. Finally, from a methodological perspective, we construct a novel proxy for sentiment contagion using a time-varying parameter vector autoregression (TVP-VAR) connectedness model, and use both the exponential general autoregressive conditional heteroscedasticity (EGARCH) and quantile-on-quantile (QQ) frameworks. This combination allows us to capture not only the average effects of sentiment contagion on green bond returns but also their heterogeneous impact across different levels of data distribution.

This study offers important policy implications for green bond market regulators and strategic insights for institutional and individual investors across countries. By demonstrating a strong correlation between sentiment contagion and its significant influence on domestic and international green bond markets, our findings provide a foundation for regulators to design informed policies to enhance the market's stability and resilience. Furthermore, investors can leverage these insights to more effectively assess valuation, implement hedging strategies, and rebalance their green bond portfolios in pursuit of their financial performance and sustainability objectives.

The paper is organized as follows. Section 2 reviews the relevant literature. Section 3 presents the theoretical framework and develops the research hypotheses. Section 4 describes the data, variable construction, and empirical methodology. Sections 5 and 6 report and discuss the empirical findings. Section 7 presents robustness analyses, and Section 8 concludes with a summary of the main results and implications for future research.

2. Literature review

We structure the literature review around two key dimensions. First, we examine studies investigating the relationship between investor sentiment and the performance of green bond markets. Second, we summarize existing research on the role of sentiment contagion in the valuation of financial assets. This dual approach enables us to identify critical gaps in our study's literature for each dimension.

2.1. Investor sentiment and green bond markets

In exploring the influence of investor sentiment on green bond returns, Piñeiro-Chousa et al. (2021, 2022) were among the first to empirically assess this relationship, utilizing Twitter data as a proxy for investor sentiment. Their findings revealed sentiment's positive and statistically significant impact on green bond returns. Similarly, Fu et al. (2024) demonstrated that sentiment derived from text mining techniques contributes to a widening of yield spreads between green and traditional bonds, thereby increasing volatility in the green bond market. Bouteska et al. (2024) further corroborated the role of sentiment in driving green bond price fluctuations. Beyond sentiment, investor attention has also been used as a predictive factor in this context. Gao et al. (2023); Pham & Cepni (2022); Pham & Huynh (2020) utilized the Google Search Volume Index and Baidu Index to measure investor attention, finding that these indicators significantly forecast both returns and volatility in green bond markets. Recent research has also extended the analysis to the spillovers between green bonds and other financial markets, with investor sentiment playing a central role. Wu & Liu (2023) used Google search data as a proxy for sentiment to examine sentiment-driven spillovers across various green finance sectors, including clean energy, transportation, building, clean water, Environmental, Social, and Governance (ESG) stocks, green bonds, and carbon markets. Their results suggest that investor sentiment intensifies dynamic intermarket linkages. Gao & Liu (2024) adopted the US Chicago Board of Options Exchange Market Volatility Index (VIX) index as an indirect sentiment measure to analyze time- and frequency-domain spillovers between rare earths and other markets such as oil, clean energy, gold, base metals, ESG assets, and green bonds. Their findings position green bonds as net receivers of shocks, with investor sentiment emerging as a key driver of market connectedness. Man et al. (2024) investigated risk spillovers among green bonds, fossil fuels, new energy, equities, and traditional bonds in China, incorporating macroeconomic sentiment indicators based on the framework of Baker & Wurgler (2006). Their study reveals time-varying, asymmetric, and heterogeneous spillover patterns, with investor sentiment significantly influencing intermarket dynamics. Le et al. (2025) expanded this line of inquiry by using a comprehensive set of direct and indirect sentiment proxies to assess their impact on return contagion across 12 major green bond markets. Their results indicate that sentiment effects are significant but vary across markets.

Despite the growing body of literature, several gaps remain in this research branch. First, while existing studies underscore the importance of investor sentiment in green bonds' performance, they have paid less attention to the differentiated roles of individual versus institutional investor sentiment in this context. Given the contrasting behavioral tendencies of these investor groups, this omission raises questions about the consistency of sentiment effects across market segments. Second, the influence of cross-border sentiment on green bonds' performance remains underexplored. Most studies have focused on domestic sentiment impacts, with limited attention, aside from Le et al. (2025), given to how investor sentiment originating in one country may affect green bonds' performance in foreign markets.

2.2. Investor sentiment contagion and asset pricing

Parallel to the green bond literature, research on sentiment contagion has established its relevance in broader asset pricing contexts. Baker et al. (2012) identified sentiment contagion between domestic

and foreign investors, proposing that optimism may drive cross-border investment, while pessimism may lead to international portfolio rebalancing. Importantly, the study finds that such contagious sentiment has adverse impacts on stock returns. Hudson & Green (2015) corroborated these findings in the context of the UK and US equity markets, confirming the predictive ability of sentiment contagion for future returns. Tsai (2017) constructed a sentiment contagion index based on foreign and trust investors, as well as dealers in Taiwan's stock market. The study revealed that while optimistic sentiment diffusion has a limited impact, pessimistic contagion significantly affects market performance, highlighting the asymmetric nature of institutional sentiment. Todd & Shuming (2017) explored sentiment correlations across major developed markets, including the US, the UK, the EU, Australia, Japan, and Canada, and their influence on future return correlations. Using a perceived loss index as a sentiment proxy, the study found that sentiment contagion strongly predicts market co-movements. Focusing on emerging markets, Zhou & Huang (2020) investigated sentiment contagion in China's agricultural futures market, using a composite index comprising the relative strength index, the psychological line index, and the turnover rate. The findings confirmed that sentiment contagion significantly influences asset prices. Gong et al. (2022) examined sentiment spillovers within individual stock investors' sentiment across industries in China, showing that shifts from overreaction to underreaction lead to substantial volatility in stock prices. Zhou et al. (2023) extended this analysis to cross-sectional stock returns, providing evidence of the systematic effects of individual investor sentiment contagion. Yang & Xiong (2024) quantified social sentiment contagion and linked it to stock price movements, finding that optimistic contagion increases the likelihood of price appreciation, while pessimistic contagion has the opposite effect.

Given the robust evidence in equity and futures markets, this research stream reveals that applying the sentiment contagion concept to green bond markets remains limited. In particular, the contagion dynamics between individual and institutional investors have not been adequately explored, leaving open questions about their influence on green bond returns. Moreover, the international transmission of sentiment contagion, especially across investor types, has received scant attention, despite its potential relevance in globally integrated green finance markets.

3. Theoretical background and hypothesis development

This research argues that sentiment between individual and institutional investors is contagious. The notion of sentiment contagion is rooted in the emotional contagion theory, first introduced by Le Bon (1896) and later expanded by Hatfield et al. (1994). Emotional contagion refers to the phenomenon whereby "emotions or opinions expressed by one individual or group spread and influence the emotions or opinions of others" (Yang & Xiong, 2024; *see also* Shi et al., 2019; Thorsten et al., 2006; Vijayalakshmi & Bhattacharyya, 2012). This contagious sentiment can occur through various channels, including verbal communication, observation of actions, and observation of consequences (Hirshleifer & Teoh, 2009), making it essential to incorporate it into economic and financial decision-making (Yang & Xiong, 2024). Schmeling (2007) documented that institutional investors consider expected individual sentiment when forming expectations in stock trading. Wang (2018, 2020) also revealed that individual and institutional investor sentiment exhibit synchronous trends. Thus, we propose the following hypothesis:

H1: There is a contagion between individual and institutional investor sentiment.

General sentiment contagion is empirically evidenced as an influential factor in explaining the performance of stock markets in the UK (Hudson & Green, 2015), China (Gong et al., 2022; Tsai, 2017; Yang & Xiong, 2024; Zhou et al., 2023), and across countries (Baker et al., 2012; Todd & Shuming, 2017). In this research, we aim to identify the role of sentiment contagion between individual and institutional investors in shaping green bond markets' performance. We consider the principles of behavioral finance theories to examine this relationship. Traditional financial theories assume that investors behave rationally, making decisions based solely on utility maximization and objective information. Specifically, Bernoulli (1738) introduced the utility theory measuring individuals' satisfaction by consuming a good or a service, which argued that rational investors pursued the maximization of their expected utility. Mill (1874) later initiated the concept of an "economic man", which further validated the rational behavior of market participants. Accordingly, to achieve the highest points on a preference scale, this person is subject to three assumptions including perfect rationality, perfect self-interest, and perfect information (Prosad et al., 2015). However, Simon (1955) constructed a behavioral model of rational choice, challenging these assumptions. Considering psychological factors, Simon introduced the aspiration levels of individuals, which defines their satisfactory alternatives. Consequently, a notion of "approximate rationality" was mentioned, which stated that rather than pursuing optimal programs, people can require feasible ones, where the pay-off exceeds a specified amount. Inheriting the concepts developed by Simon (1955), behavioral finance theories incorporated the psychological and emotional factors of market participants into their financial decision-making (Pompian, 2011; Sewell, 2010). They posit that investors are not perfectly rational but are instead influenced by sentiment, cognitive biases, and heuristics (Statman, 1999).

A central framework within behavioral finance is prospect theory, introduced by Tversky and Kahneman (1979), which departs from the classical expected utility theory of Bernoulli (1738). Prospect theory posits that individuals assess outcomes in relation to a reference benchmark and exhibit loss aversion, leading to systematic deviations from rational behavior under uncertainty. This theory provides a foundation for understanding how investor sentiment can affect asset pricing, particularly under volatile or uncertain market conditions.

In addition to prospect theory, the concept of socially responsible investment (SRI) and the planned behavior theory developed by Ajzen (1985) also support the theoretical framework of this study. While SRI lacks a universally accepted definition, it is commonly understood as an investment approach integrating environmental and social considerations into financial analyses (Anastasia, 2003). Prior research such as the work of Adam & Shauki (2014) and of Paetzold & Timo (2014) highlighted that investor intention is a key determinant of SRI decisions, aligning with the core premise of the theory of planned behavior. This theory posits that individual actions are guided by behavioral intentions, which reflect the level of effort and commitment an individual is willing to invest in a particular behavior.

Behavioral finance research has incorporated emotional contagion as a key channel through which sentiment spreads across investors, affecting expectations, trading decisions, and ultimately asset prices (Baker et al., 2012 ; Hudson & Green, 2015; Todd & Shuming, 2017; Tsai, 2017; Zhou & Huang, 2020; Gong et al., 2022; Zhou et al., 2023; Yang & Xiong, 2024). While this empirical evidence primarily focuses on stock markets, the green bond market exhibits several structural and behavioral

features that may render it particularly susceptible to sentiment contagion. On the one hand, green bonds are closely associated with the concept of SRI, where investment decisions reflect not only financial interests but also environmental and social returns. Consequently, green bond demand is inherently preference-based, making prices more responsive to emotional contagion among market participants. On the other hand, according to behavioral and prospect theories, assets whose values depend on subjective beliefs and reference points are more vulnerable to sentiment-driven fluctuations. As green bonds have these features, the sentiment contagion between individual and institutional investors can lead to coordinated changes in investors' expectations and trading behavior, thereby affecting green bond returns. Therefore, we develop a second hypothesis as follows:

H2: The domestic sentiment contagion between individual and institutional investors significantly impacts green bond returns.

Sentiment contagion is not limited to investor groups within a single market but extends across international financial markets. Baker et al. (2012) identified two primary channels of cross-country sentiment contagion: (1) Optimistic investors in one country may invest in another, and (2) pessimistic investors may reallocate risky assets globally. Hudson & Green (2015) confirmed this phenomenon by showing that US investor sentiment predicts UK equity returns significantly. With increasing hedging demand and capital liberalization, investors are more engaged in international diversification (Le et al., 2025), accessing diverse sources of information and using sentiment to infer price changes across markets (Lin & Ito, 1994; Mervyn & Sushil, 1990). On the basis of this analysis, we propose the following hypotheses to test how sentiment contagion affects foreign green bonds' performance:

H3: The foreign sentiment contagion between individual and institutional investors significantly impacts green bond returns.

4. Research design

The section introduces the variables and econometric models used to test our hypotheses.

4.1. Research variables

The dependent variable in this study is the performance of the green bond market. In line with prior research (Le et al., 2025; Pham & Cepni, 2022; Pham & Huynh, 2020; Piñeiro-Chousa et al., 2021, 2022), we use the daily return of green bond indices as a proxy for market performance. With the growing significance of green finance, several global green bond indices have emerged, including the Standard & Poor's (S&P) Green Bond Index, Bloomberg Barclay's Morgan Stanley Capital International (MSCI) Green Bond Index, and J.P. Morgan Emerging Markets Green Bond Index. Although these indices differ in their construction methodologies and inclusion criteria, they exhibit similar market dynamics and strong correlations (Reboredo, 2018; Reboredo & Ugolini, 2020). Therefore, we adopt the green bond indices compiled by the Bloomberg database, which are in line with the existing literature in this domain.

The independent variables are sentiment contagion measures, constructed using the indices of individual and institutional investor sentiment. Accordingly, we utilize the investor sentiment index (Sentix) survey data provided by Sentix GmbH. This independent German research institute collects

information on investors' preferences, assessments, and expectations regarding financial markets and macroeconomic trends. The Sentix index is a qualitative diffusion measure that ranges from −100, indicating strong deterioration, to +100, indicating strong improvement, with zero denoting neutral expectations relative to the current conditions.

This sentiment dataset is particularly well-suited to our research for three key reasons. First, the monthly surveys conducted by Sentix GmbH anonymously solicit investors' views on short- and medium-term market directions across major regions, including Europe, the US, Asia (excluding Japan), and Japan. This provides a direct and timely measure of investor sentiment. Second, the survey methodology explicitly distinguishes between individual and institutional investors. The respondents must register using a verified institutional email address to participate as an institutional investor, ensuring accurate classification. This distinction aligns precisely with our objective of examining the contagion between individual and institutional investor sentiment and its effect on green bond markets' performance. Third, the Sentix sentiment indicators have been widely used in previous empirical studies (e.g., Corredor et al., 2013; Debata et al., 2018; Gao et al., 2021; Schmeling, 2007; Wang & Duxbury, 2021).

Although Sentix provides regional sentiment data for Asia (excluding Japan), Japan, Eastern Europe, the EU, Latin America, and the US, green bond index data are not uniformly available across all these regions. To ensure consistency in data coverage, our analysis focuses on four markets: Asia (excluding Japan), Japan, the EU, and the US, with the Chinese green bond market serving as the representative for Asia (excluding Japan).

For the control variables, following previous literature studying the nexus between investor sentiment and bonds (e.g., Le et al., 2025; Wang & Duxbury, 2021; Reis & Pinho, 2020; Bethke et al., 2017), we selected the inflation rate, the market volatility index, and the economic policy uncertainty index to serve as control variables. Among these variables, the market volatility index is not unified for all markets; therefore, following previous research, we adopted the Shanghai Stock Exchange 50 Exchange-Traded Fund (ETF) volatility index, the Nikkei stock average volatility index, the Chicago board options exchange volatility index, and the Eurozone stocks volatility index (VSTOXX EUR) to proxy the market volatility of China, Japan, the US, and the EU, respectively.

Regarding the study period, green bond index data's availability varies across regions. While indices for China, the EU, and the US were introduced earlier, Japan's green bond index data only became fully available from October 2021. To maintain consistency across all markets, we define our sample period from 3 January 2022 to 31 December 2024. All green bond index data are sourced from the Bloomberg database and are available daily, whereas investor sentiment data are provided monthly. To reconcile the difference in data frequency, we apply linear interpolation to the monthly data of Sentix sentiment, inflation rate, and economic policy uncertainty, following the methodology of Bethke et al. (2017) and Wang and Duxbury (2021).

Table 1 provides an overview of the variables used in our research for the four green bond markets mentioned.

Table 1. Overview of research variables.

Markets	Notation	Variables
China	*regbcn*	Financial Times Stock Exchange (FTSE) Chinese green bond index, Onshore (CNY)
	invicn	China's individual investor sentiment index
	insticn	China's institutional investor sentiment index
	inflcn	China's inflation rate
	volacn	Shanghai Stock Exchange 50 ETF volatility index
	epucn	China's economic policy uncertainty index
Japan	*regbjp*	Bloomberg green bond index (JPY)
	invijp	Japan's individual investor sentiment index
	instijp	Japan's institutional investor sentiment index
	infljp	Japan's inflation rate
	volajp	Nikkei stock average volatility index
	epujp	Japan's economic policy uncertainty index
The US	*regbus*	Bloomberg's green bond index (USD)
	invius	The US individual investor sentiment index
	instius	The US institutional investor sentiment index
	influs	The US's inflation rate
	volaus	Chicago board options exchange volatility index
	epuus	The US's economic policy uncertainty index
EU	*regbeu*	Bloomberg's green bond index (EUR)
	invieu	EU's individual investor sentiment index
	instieu	EU's institutional investor sentiment index
	infleu	EU's inflation rate
	volaeu	Euro STOXX 50 volatility VSTOXX EUR index
	epueu	EU's economic policy uncertainty index

4.2. Research models

We adopt a multimethod approach comprising three econometric models to investigate our research hypothesis empirically. First, we use a TVP-VAR model to compute the total spillover index, a proxy for sentiment contagion between individual and institutional investors. Second, we apply the EGARCH model to examine the influence of investor sentiment and sentiment contagion on green bond returns. Finally, we utilize the QQ regression technique to explore how the effects of the explanatory variables vary across different quantiles of both dependent and independent variables. Each model is estimated separately for each green bond market and sentiment indicator.

4.2.1. The TVP-VAR model

Tsai (2017) applied the traditional vector autoregression (VAR)-based connectedness framework developed by Diebold & Yilmaz (2009, 2012, 2014) to construct a sentiment contagion index for the Taiwanese stock market. Building on this foundation, we compute a spillover index to measure sentiment contagion between individual and institutional investors across green bond markets.

However, instead of the conventional VAR model, we adopt the TVP-VAR approach introduced by Antonakakis et al. (2018) and Gabauer & Antonakakis (2017).

There are two primary reasons for preferring the TVP-VAR framework. First, the Diebold and Yilmaz model requires the specification of a predictive horizon and a rolling estimation window, which can be problematic when capturing dynamic and time-varying spillovers. The TVP-VAR model addresses these limitations by incorporating stochastic volatility via the Kalman filter, as proposed by Koop et al. (1996), allowing for evolving variance structures and more accurate modeling of temporal dependencies. Second, the TVP-VAR method mitigates issues related to arbitrary window selection, data loss, and sensitivity to outliers, which are common drawbacks in traditional connectedness models (Wu & Liu, 2023).

Based on the Bayesian information criterion, a stationary TVP-VAR model with one lag is specified as follows:

$$z_t = B_t z_{t-1} + u_t, u_t \mid \mathrm{T}_t \sim N(0, S_t) \; ; \tag{1}$$

$$B_t = B_{t-1} + v_t, v_t \mid \mathrm{T}_t \sim N(0, R_t) \, , \tag{2}$$

where z_t and u_t denote $N \times 1$ vectors of the conditional volatilities and disturbance terms, respectively, associated with an $N \times N$ time-varying variance–covariance matrix; S_t, B_t, and v_t reflect $N \times Np$ vectors of dimensional time-varying coefficient and error disturbance with a variance-covariance matrix. Accordingly, R_t and B_t evolve on their own lagged values and an $N \times Np$ disturbance matrix. The TVP-VAR(1) model can be equivalently expressed in a time-varying parameter vector moving average (VMA) form as follows:

$$z_t = B_t z_{t-1} + u_t = \sum_{j=0}^{\infty} A_{jt} u_{t-j} \, , \tag{3}$$

where A_{jt} is an $N \times N$ matrix of dimensional coefficients.

This VMA form is essential for computing connectedness measures using the generalized impulse response function and the generalized forecast error variance decomposition (GFEVD), as proposed by Koop et al. (1996) and Pesaran & Shin (1998). Within the TVP-VAR framework, we focus on the GFEVD, which measures the contribution of shocks from variable j in the H-step error variance to variable i. The formulation is given below:

$$\Psi_{ij,t}(H) = \frac{s_{ij,t}^{-1} \sum_{h=0}^{H-1} (l_i A_{ht} S_t l_j)^2}{\sum_{h=0}^{H-1} (l_i A_{ht} S_t A_{ht} l_j)^2} \, , \tag{4}$$

where $\Psi_{ij,t}(H)$ is the H-step ahead GFEVD and l_i is a dummy variable with a value of 1 on the i-th position, and 0 otherwise; $\tilde{\Psi}_{ij,t}(H) = \dfrac{\Psi_{ij,t}(H)}{\sum\limits_{j=1}^{N}\Psi_{ij,t}(H)}$ is the normalization of $\Psi_{ij,t}(H)$.

Using the GFEVD, we construct the total spillover index, which captures the average level of interconnectedness between investor sentiments and is used to measure sentiment contagion (*conse*), as follows:

$$conse_t(H) = \frac{\sum\limits_{i,j=1,i\neq j}^{N}\tilde{\Psi}_{ij,t}(H)}{\sum\limits_{i,j=1}^{N}\tilde{\Psi}_{ij,t}(H)}\times 100. \qquad (5)$$

In our study, i and j in Equation (5) represent the sentiment indices of individual and institutional investors, respectively, forming a two-node system in which one acts as a shock transmitter and the other as a receiver. Within this framework, two possible spillover channels exist: Shocks originating from individual investor sentiment that influence the forecast error variance of institutional investor sentiment, and vice versa. The variance decomposition approach used here partitions each variable's forecast error variance into the components attributable to shocks from different sources within the system. Each spillover contributes to the overall connectedness, and their aggregate constitutes the total spillover measure. These totals are expressed as a percentage of the system's total forecast error variation, producing the spillover index. Importantly, this index captures dynamic interactions rather than the raw sentiment levels of individual or institutional investors. Following Tsai (2017) and Wan et al. (2024), we adopt this spillover index as a proxy for contagion between individual and institutional investor sentiment.

This index is computed separately for each green bond market to reflect market-specific sentiment dynamics.

4.2.2. EGARCH model

To assess the impact of investor sentiment and sentiment contagion on green bond markets' performance, we use the EGARCH model developed by Nelson (1991). This model is widely recognized in financial econometrics for its ability to capture volatility asymmetries and conditional heteroscedasticity more effectively than other general autoregressive conditional heteroscedasticity (GARCH) family models, such as GARCH and Glosten-Jagannathan-Runkle (GJR)-GARCH (Hadad & Kedar-Levy, 2024; Wang et al., 2022; Wang & Duxbury, 2021).

Given that sentiment spillovers may exhibit conditional heteroscedasticity (Wu & Liu, 2023), the EGARCH framework is particularly suitable. It accommodates asymmetric effects and allows for modeling mean and volatility spillovers (Hadad & Kedar-Levy, 2024; Skintzi & Refenes, 2006).

The EGARCH model specification is as follows, with the daily return of green bond indices as the dependent variable:

$$regb_t = \mu_t + \varepsilon_t, \tag{6}$$

where *regb* is the daily return of the green bond index for each market. Following the existing literature, green bonds' daily returns are measured by the first natural log difference $regb_t = \ln(P_t) - \ln(P_{t-1})$, in which P is the closing price of the green bond index, μ denotes a constant term, and ε reflects an error term. The conditional variance model is

$$log(\sigma_t^2) = \omega + \alpha \left[\frac{|\varepsilon_{t-1}|}{\sigma_{t-1}} - \frac{\sqrt{2}}{\pi} \right] + \beta \left(\frac{\varepsilon_{t-1}}{\sigma_{t-1}} \right) + \gamma log(\sigma_{t-1}^2) + \delta_{sent} sentiment_t + \delta_{control} control_t, \tag{7}$$

where σ_t^2 measures the conditional variance of daily return; *sent* is either individual investor sentiment, institutional investor sentiment (measured by the natural logarithm of sentiment index), or sentiment contagion; ω, α, β measure the constant, symmetric, and asymmetric factors of the general autoregressive model; γ is the persistence of conditional volatility; and δ is our parameter of interest, showing sentiment contagion and control variables on green bond returns.

Following Anderson & Burnham (2004); Wang & Duxbury (2021); Wang et al. (2022), we report the log-likelihood function (LLF) and Akaike's information criterion (AIC) for each model. The LLF measures how well a model fits the data, with higher values indicating a better fit under maximum likelihood estimation. Maximization likelihood estimation is widely used in statistical inference (Pan & Fang, 2002) because it provides a fundamental quantity for model selection along with likelihood inference (Anderson & Burnham, 2004). To balance the models' fit against their complexity, we also report the AIC values. The AIC is a valuable method of model selection, and there is a strong relationship between AIC and LLF, such that the minimized AIC corresponds to the maximization point of LLF and thus models with the smallest AIC appear to be the best (Anderson & Burnham, 2004).

4.2.3. QQ model

To gain deeper insight into how investor sentiment and sentiment contagion affect green bond returns across different distributional segments, we apply the QQ regression method developed by Sim & Zhou (2015). This technique extends the standard quantile regression framework introduced by Koenker & Bassett (1978) by incorporating nonparametric estimation.

The QQ model is well-suited for our research for two main reasons. First, unlike traditional quantile regression, which estimates the effect of an independent variable across quantiles of the dependent variable, the QQ approach evaluates the relationship across quantiles of both variables (Sun et al., 2023), offering a more nuanced understanding of their interaction (Chang et al., 2020). Second, the QQ model effectively captures full dependence structures, including tail behavior and structural breaks, which are often overlooked in standard quantile models (Sim & Zhou, 2015; Sun et al., 2023).

The basic model is as follows:

$$regb_t = \beta^\theta(sent_t) + u_t^\theta, \tag{8}$$

where *regb* is the daily green bond return; *sent* is either individual investor sentiment, institutional investor sentiment, or sentiment contagion; θ is the θth of the quantiles of the conditional distribution of return; u_t^θ is the quantile error term; and $\beta^\theta(\bullet)$ is the slope of the relationship between green bond returns and sentiment.

To measure the impact of the θth quantile of the return on the τth quantile of the sentiment, proxied by $sent^\tau$, β^θ can be linearized by the first-order Taylor rule as follows:

$$\beta^\theta(sent_t) \approx \beta^\theta(sent^\tau) + \beta^{\theta'}(sent^\tau)(sent_t - sent^\tau), \tag{9}$$

where $\beta^{\theta'}$ is the partial derivative of $\beta^\theta(sent^\tau)$ and $\beta^{\theta'}(sent^\tau)$ in terms of θ and τ.

Equation (8) can be rewritten as

$$\beta^\theta(sent_t) \approx \beta_0(\theta, \tau) + \beta_1(\theta, \tau)(sent_t - sent^\tau). \tag{10}$$

By changing Equation (9) in Equation (7), we obtain the last equation to investigate the impact of investor sentiment or sentiment contagion on daily green bond returns.

$$regb_t \approx \beta_0(\theta, \tau) + \beta_1(\theta, \tau)(sent_t - sent^\tau) + u_t^\theta, \tag{11}$$

where $\beta_0(\theta, \tau) + \beta_1(\theta, \tau)(sent_t - sent^\tau)$ is the conditional quantile of the green bond return. Following Sim and Zhou (2015), we set a bandwidth parameter $h = 0.05$.

We do not present the estimation with control variables from the QQ model for two main reasons. First, the original QQ surface plot concept was introduced for bivariate scenarios, which map quantiles of the dependent variable against the quantiles of a core explanatory variable. As such, it is not possible to meaningfully display QQ estimated coefficients for multiple regressors on the same two-axis surface. If additional variables are added, they would necessarily require separate surface plots for each variable and should be treated as explanatory variables. Furthermore, while the QQ approach provides valuable visual evidence on the distributional relationship between sentiment contagion and green bond returns, our primary empirical conclusions are based on the numerical estimates from the EGARCH models.

5. Empirical findings

In this section, we present the empirical findings of our research. It begins with the descriptive statistics of the research variables. Next, we report the contagion results between individual and

institutional investor sentiment. Additionally, we show the findings of how domestic sentiment contagion affects green bond returns. Finally, we provide the results of the role of sentiment contagion in the performance of foreign green bond markets. For each EGARCH approach, we present two sets of results, one without control variables serving as a baseline and the other with control variables acting as the main findings of the empirical analysis.

5.1. Descriptive statistics

Table 2 presents the summary statistics for the green bond returns and investor sentiment indices across the selected markets. The four green bond markets include Asia (excluding Japan, with China (*cn*) as a representative), Japan (*jp*), the EU (*eu*), and the US (*us*).

Table 2. Descriptive statistics of investor sentiment and green bond indices.

Variable	Mean	Std. dev.	Skewness	Kurtosis	Jarque-Bera	ADF test
regbcn	0.0144	0.0547	−0.0839	7.1661	566.44***	−24.734***
regbjp	−0.0279	0.3869	0.3754	4.2248	67.262***	−26.370***
regbus	−0.0251	0.5854	0.2447	4.3961	71.308***	−24.866***
regbeu	−0.0166	0.3886	0.3330	3.9656	44.845***	−26.315***
invicn	0.9389	1.9264	−0.8189	2.1225	112.49***	−3.4385**
invijp	−0.1311	1.9655	−0.1099	1.4493	79.926***	−1.8642**
invius	−0.4091	1.9374	0.1990	1.5076	77.731***	−1.8892**
invieu	−2.2024	1.4762	1.7646	5.4163	596.11***	−3.3077***
insticn	0.9203	1.8102	−0.5885	1.9346	82.1323***	−2.1696**
instijp	0.4224	1.8552	−0.4804	1.7919	77.6323***	−1.7241**
instius	−1.8413	1.7238	1.3504	3.5049	245.97***	−2.2811**
instieu	−1.5684	2.1921	1.0029	2.5192	138.64***	−2.2883**
inflcn	0.0081	0.0098	0.6353	2.0476	82.167***	−5.3273***
infljp	0.0288	0.0069	−1.0402	5.1917	29.756***	−4.8556***
influs	0.0034	0.0025	1.4754	5.4095	47.289***	−5.6833***
infleu	0.0039	0.0050	1.0267	4.6293	22.388***	−5.4383***
volacn	0.5288	0.4425	1.6053	6.2011	69.77***	−23.493***
volajp	0.7315	0.1788	1.2070	6.9109	69.806***	−9.9213***
volaus	0.6169	0.2842	0.3326	2.0405	44.423***	−13.531***
volaeu	0.6628	0.2805	0.5817	2.6609	47.846***	−12.641***
epucn	0.9809	0.2752	−0.1013	2.6549	5.2195***	−9.6317***
epujp	0.0615	0.1303	−0.2119	2.8213	6.8963**	−5.6102***
epuus	0.1175	0.5139	0.0408	4.0242	34.398	−10.611***
epueu	1.1529	0.1838	0.5760	2.8142	44.375	−8.3024***

Notes: This table reports the descriptive statistics of variables used in the research for four green bond markets. All variables are defined in Table 1.

The data reveal that the average returns in green bond markets are relatively low over the sample period, with China being the only market to exhibit a positive mean return. The skewness values for

most markets are positive, except for China, indicating right-skewed distributions. Furthermore, the kurtosis values for all markets exceed the benchmark value of 3, suggesting that the return distributions have fat tails.

Regarding the investor sentiment indices, the average values are predominantly negative, reflecting a generally pessimistic outlook among investors during the research period. These sentiment indicators also display higher volatility than green bond returns, as measured by the standard deviation. The distributional characteristics of the sentiment indices show left skewness and relatively thin tails, as evidenced by their skewness and kurtosis statistics.

The results of the Jarque-Bera and augmented Dickey-Fuller (ADF) tests are statistically significant for all variables, indicating that the data deviate from normality and exhibit stationarity.

5.2. The contagion between individual and institutional investor sentiment

In this research, we use the TVP-VAR model to compute the total spillover index (TSI), quantifying the degree of sentiment contagion between individual and institutional investors. A higher TSI value indicates greater interconnectedness and sentiment transmission between the two investor groups. The average TSI values for each market are reported in Table 3.

Table 3. Average joint connectedness.

Markets	TSI	Individual sentiment	Institutional sentiment
China	34.18	3.89	−3.89
Japan	77.21	3.26	−3.26
US	59.98	0.38	−0.38
EU	82.27	−2.35	2.35

Notes: This table reports the average joint connectedness between individual and institutional investor sentiment.

The TSI values in Table 3 reveal notable differences in sentiment contagion across markets. China exhibits the lowest level of sentiment contagion among the four regions, with an average TSI of 34.18%, suggesting relatively weak interdependence between individual and institutional investor sentiment. The US follows, with a moderate contagion level of 59.98%. In contrast, Japan and the EU demonstrate significantly higher contagion levels, with average TSIs of 77.21% and 82.27%, respectively, indicating strong sentiment transmission between investor groups in these markets.

In addition to the overall contagion index, Table 3 also reports the net spillover values, which measure the directional influence of sentiment between investor types. A positive net spillover indicates that a sentiment type acts as a net transmitter, exerting more influence than it receives, while a negative value denotes a net receiver. The results show that individual investor sentiment serves as a net transmitter in China, Japan, and the US, implying that individual sentiment exerts a more substantial influence on institutional sentiment in these markets. Conversely, institutional sentiment is the net transmitter in the EU, suggesting that institutional investors play a more dominant role in shaping the overall market sentiment.

As revealed by the TSI, the variation in sentiment contagion across markets underscores the influence of structural and behavioral factors in shaping investors' interactions. China reveals the

lowest sentiment contagion, which may be attributed to its relatively segmented market structure, where retail investors dominate trading activity and institutional investors operate with distinct strategies and information sources. Regulatory constraints and limited transparency further reduce the interaction between these groups. In contrast, Japan, the US, and the EU exhibit higher sentiment contagion, reflecting more mature and integrated financial systems. Both investor groups have access to similar information flows in these markets and are influenced by shared macroeconomic signals, media narratives, and social sentiment.

5.3. The impact of domestic sentiment contagion on green bonds' performance

Given the sentiment contagion between individual and institutional investors documented above, we examine how the sentiment contagion of a country impacts its green bond market's performance using the EGARCH and QQ models.

Table 4 reports the estimated parameters capturing the effect of domestic sentiment contagion on green bond returns for the EGARCH method.

Table 4. Impact of domestic sentiment contagion on green bonds' performance.

Panel A: Without control variables

Markets	Constant	Coefficients	LLF	AIC
China	3.8999** (1.8067)	0.0759** (1.8067)	−2484.4	6.3852
Japan	−18.889*** (3.8953)	0.4005*** (0.0958)	−4048.4	10.387
US	3.7929*** (0.4729)	−0.1999*** (0.0224)	−4327.2	11.102
EU	−6.9476** (2.9921)	0.2091*** (0.0734)	−3918.4	10.059

Notes: This table reports the impact of sentiment contagion between individual and institutional investors of a country on its green bond returns, using the EGARCH model without control variables.

Panel B: With control variables

Markets	Constant	Sentiment	Inflation	Volatility	EPU	LLF	AIC
China	−1.2799***	0.2558***	0.7297	−0.1327***	−0.0413	−1588.8	4.0969
	(0.0726)	(0.0280)	(1.8451)	(0.0309)	(0.0525)		
Japan	−5.9533***	0.9685***	3.6606	−0.1279	0.5964***	−2239.4	5.7628
	(1.2732)	(0.3468)	(3.9218)	(0.1201)	(0.1694)		
US	−0.4849	−0.0916*	0.0817*	0.2965	0.2916	−2069.8	5.3364
	(0.6477)	(0.2446)	(0.0397)	(0.0442)	(0.2545)		
EU	−4.8255*	1.1394*	0.0156**	0.6433	0.3464	−2055.5	5.2919
	(2.7625)	(0.6381)	(0.0647)	(0.6539)	(0.8285)		

Notes: This table reports the impact of sentiment contagion between the individual and institutional investors of a country on its green bond returns. Inflation rate is the growth rate since the same period in the previous year. Volatility and EPU are the natural logarithm of market volatility and the economic policy uncertainty indicator, respectively.

The sentiment coefficients column of Panel B in Table 4 is our primary parameter of interest, reflecting the sensitivity of green bonds' performance to changes in investor sentiments' dynamics. Overall, the results suggest that sentiment contagion significantly influences green bond returns, although the magnitude and direction of the effect vary across markets. The EU green bond market

exhibits the strongest positive response, with a one-unit increase in sentiment contagion associated with a 1.14% rise in returns, indicating that synchronized investor sentiment may enhance market optimism and investment flows in the EU's green bond sector. The Japanese market follows, with a moderate positive effect, where contagion contributes to a 0.96% return increase, suggesting that sentiment alignment between investor groups supports green bonds' performance in the region.

In China, the impact of sentiment contagion is positive but relatively mild compared with the EU and Japan, with a coefficient of 0.25, reflecting the lower contagion level observed earlier and possibly the segmented nature of its investor base. Interestingly, the US market displays a negative relationship, where increased sentiment contagion leads to a 0.09% decline in green bond returns. This counterintuitive result may indicate that heightened sentiment alignment in the US is associated with risk aversion or market corrections.

Most control variables are statistically insignificant, suggesting limited direct effects on green bond returns. In instances where the control variables are significant, their coefficients indicate economically meaningful impacts (for example, the coefficient of economic policy uncertainty (EPU) is 0.59 for Japanese green bonds), reflecting the role of broader market and macroeconomic conditions on the performance of green bonds.

Given the significant role of domestic sentiment contagion on green bond returns, evidenced by the average coefficients estimated by the EGARCH model in Table 4, we are interested in examining how the effects vary across different distribution levels of green bond returns and sentiment contagion. Hence, we plot the three-dimensional (3D) surface of QQ estimates, as shown in Figure 1.

In China, the QQ plot reveals a relatively mild and predominantly positive relationship between sentiment contagion and green bond returns. Coefficient values range from approximately −0.08 to 0.1, with the most notable positive effects concentrated in the middle and upper quantiles of green bond returns. The upper quantiles of sentiment contagion (i.e., 0.90–0.95) appear to exert the most decisive influence on the corresponding upper quantiles of the returns, suggesting that sentiment alignment has a modest but more pronounced effect during bullish market phases. These findings are consistent with the earlier EGARCH results, which indicated limited contagion and behavioral transmission in China's segmented market.

In Japan, the QQ surface indicates a strong and positive relationship, particularly at the upper quantiles of green bond returns (0.80–0.95). Interestingly, the most significant effects are concentrated in the lower quantiles of sentiment contagion (0.10–0.40) and the upper quantiles of returns (0.85–0.95). This suggests that even modest increases in sentiment contagion can substantially enhance green bonds' performance during favorable market conditions, highlighting the sensitivity of Japan's green bond market to behavioral signals.
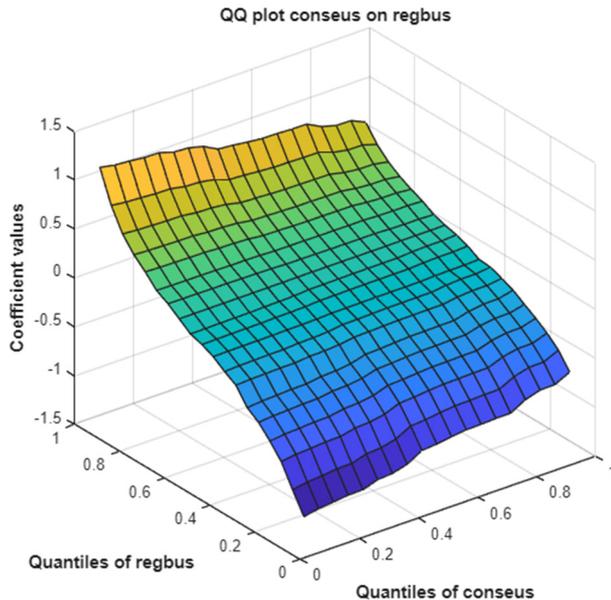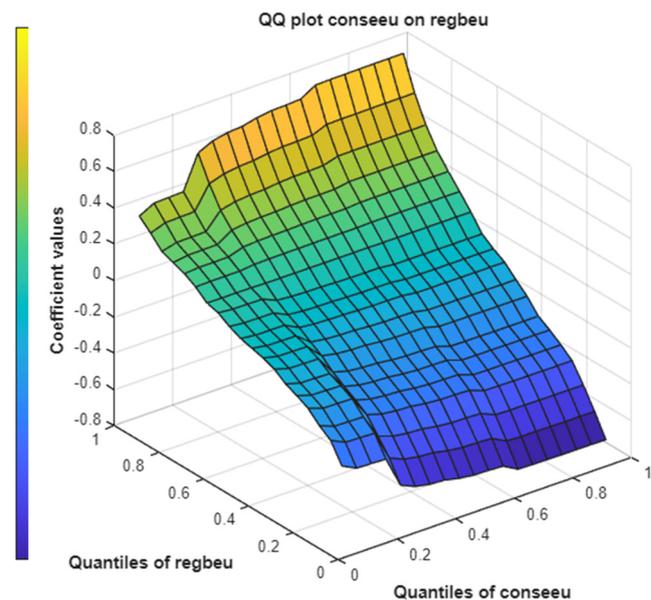
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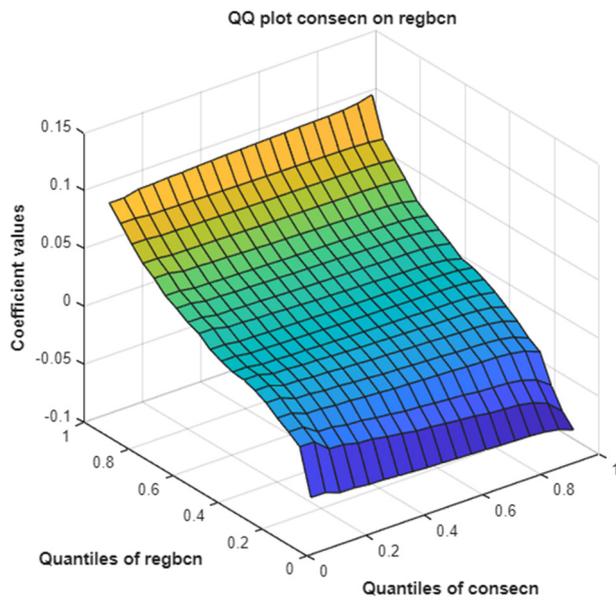
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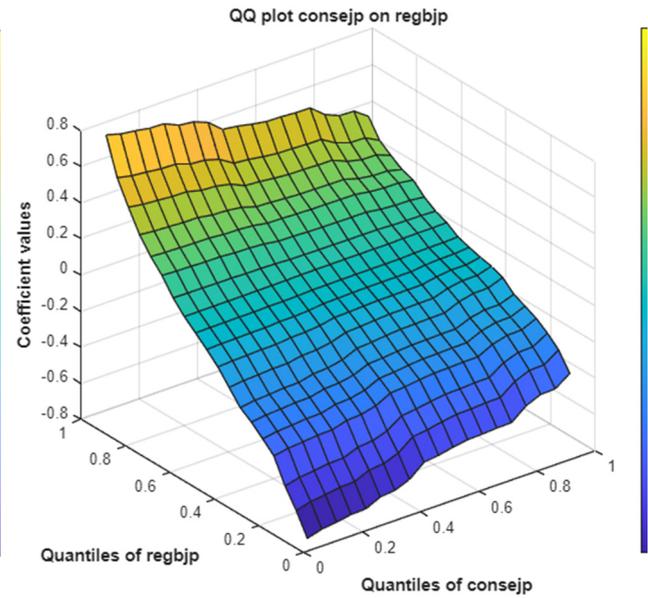
The US

The EU

Figure 1. Surface plot of QQ estimates.

Notes: This figure shows the three-dimensional surface plots of the relationship between domestic sentiment contagion and the green bond market's performance, estimated by the QQ method. Here, *consecn, consejp, conseus,* and *conseeu* are the sentiment contagion indicators of China, Japan, the US, and the EU, respectively; *regbcn, regbjp, regbus,* and *regbeu* are the green bond returns of China, Japan, the US, and the EU, respectively.

The QQ plot for the US presents a more asymmetric pattern. Coefficient values range from approximately −1 to 1, indicating positive and negative effects depending on the quantile combinations. While sentiment contagion positively influences the upper quantiles of green bond returns (0.70–0.95), the most potent positive effects are observed when lower quantiles of contagion (0.25–0.40) interact with upper quantiles of returns (0.80–0.95). However, the overall surface is dominated by negative coefficients, particularly at higher levels of sentiment contagion, suggesting that excessive alignment

in investor sentiment may coincide with declining green bond performance. This finding aligns with the EGARCH results, reinforcing that sentiment contagion in the US may signal market corrections or defensive institutional behavior.

In the EU, the QQ plot displays a varied but generally positive relationship, with coefficient values ranging from −0.8 to 0.6. The most substantial positive effects are concentrated in the higher quantiles of sentiment contagion (0.70–0.95) and green bond returns (0.75–0.95). This pattern suggests increased sentiment alignment between investor groups tends to support green bonds' performance during bullish market conditions. These results are consistent with the EU's policy-driven green finance environment, where behavioral factors may amplify the effects of regulatory and environmental incentives.

5.4. *The impact of foreign sentiment contagion on green bonds' performance*

Because of the increasing demand for hedging and capital liberalization, investors in one country may make green investments in other countries. Related parties in international diversification may be concerned about whether sentiment contagion is transmitted between green bond markets and can impact their performance. Therefore, we explore how foreign sentiment contagion affects the green bond returns of the abovementioned four markets using the EGARCH and QQ models.

5.4.1. Foreign sentiment contagion and the Chinese green bond market

The EGARCH estimations for the association between foreign sentiment contagion and the return of the Chinese green bonds are presented in Table 5.

Table 5. Impact of foreign sentiment contagion on Chinese green bonds.

Panel A: Without control variables

From markets	Constant	Coefficients	LLF	AIC
Japan	11.821*** (1.0319)	0.0318** (0.0136)	−2567	6.6024
US	0.8985*** (0.3375)	0.0234*** (0.0082)	−2442.7	6.2758
EU	−19.211*** (0.0066)	0.2303*** (0.0021)	−2638	6.7874

Notes: This table reports the impact of foreign sentiment contagion between individual and institutional investors on China's green bond return's without control variables.

Panel B: With control variables

From markets	Constant	Sentiment	Inflation	Volatility	EPU	LLF	AIC
Japan	0.9348	0.1407*	2.8562	−0.0751	0.0495	−1347.7	3.4864
	(2.5662)	(0.6699)	(7.9647)	(0.1378)	(0.2299)		
US	−0.7471***	0.1952***	2.9514	−0.1028*	−0.2663**	−1593.7	4.1092
	(0.1097)	(0.0357)	(2.5354)	(0.0570)	(0.1169)		
EU	−2.0958***	0.5005**	3.5557	0.0192	−0.3552*	−1450.8	3.7435
	(0.7348)	(0.2103)	(5.5048)	(0.1204)	(0.2109)		

Notes: This table reports the impact of sentiment contagion between individual and institutional investors of foreign markets on the green bond returns of China with control variables. The inflation rate is the growth rate compared with the same period in the previous year. Volatility and EPU are the natural logarithm of market volatility and the economic policy uncertainty indicators, respectively.

Panel B in Table 5 presents compelling evidence that sentiment contagion from foreign markets significantly influences the performance of China's green bond market. However, the magnitude of this impact varies across different countries, suggesting heterogeneous transmission effects of investor sentiment.

Specifically, sentiment contagion originating from Japan and the US exerts a relatively modest influence on Chinese green bond returns. The estimated slope coefficients are 0.14 and 0.19, respectively, indicating that a one-unit increase in sentiment contagion from Japan and the US corresponds to only a 0.14% and 0.19% increase in Chinese green bond returns. While statistically significant, these effects suggest limited cross-border sentiment transmission from these markets.

In contrast, sentiment contagion from the EU demonstrates a substantially more potent effect. The coefficient of 0.5 implies that a one-unit increase in EU sentiment contagion is associated with a 0.5% rise in Chinese green bond returns. This pronounced effect may reflect deeper financial integration or more substantial environmental policy alignment between China and the EU, which could amplify sentiment spillovers in the green finance domain.

Figure 2 shows the impact of foreign sentiment contagion on China's green bond returns at various distribution levels of contagion and returns. Figure 2 illustrates the nonlinear and asymmetric relationship between foreign sentiment contagion and Chinese green bond returns across different quantiles. The surface plots for Japan, the US, and the EU reveal that the positive influence of sentiment contagion is predominantly concentrated in the medium and upper quantiles (0.60–0.95) of both the contagion indicators and Chinese green bond returns. This suggests that when both foreign sentiment and Chinese green bonds' performance are high, sentiment contagion exerts a more substantial positive effect.

Conversely, the plots indicate that negative impacts are more pronounced at the lower quantiles (0.10–0.40) of Chinese green bond returns, particularly when foreign sentiment contagion is also low. This asymmetry highlights that sentiment contagion may exacerbate downturns in the Chinese green bond market under pessimistic conditions.

These findings are consistent with the results obtained from the EGARCH models, reinforcing the conclusion that elevated foreign sentiment contagion, especially from the EU, contributes positively to China's green bond market's performance.

Japanese sentiment contagion and Chinese green bonds
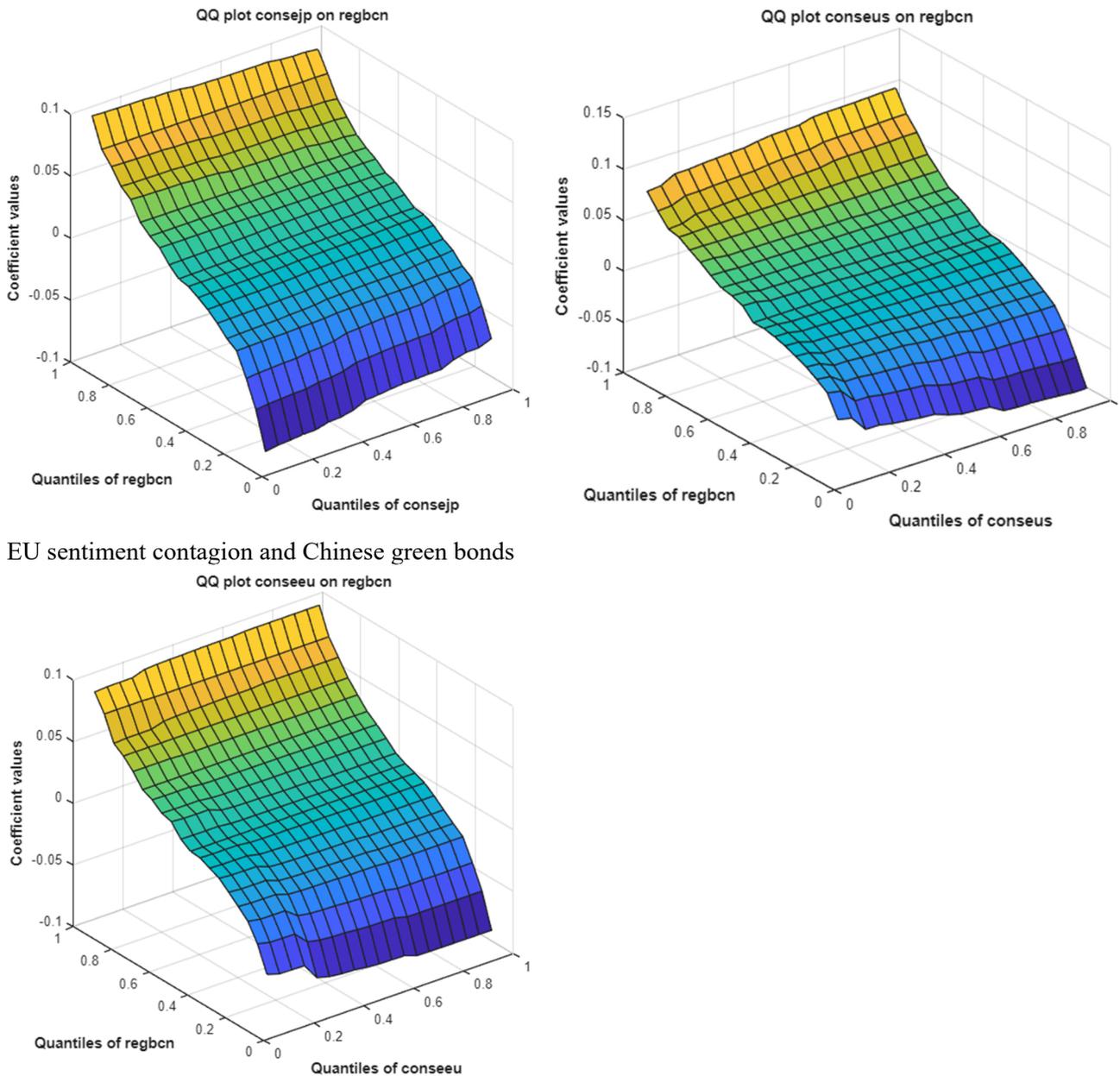
US sentiment contagion and Chinese green bonds

EU sentiment contagion and Chinese green bonds

Figure 2. Surface plot of QQ estimates.

Notes: This figure shows the 3D surface plot of the relationship between foreign sentiment contagion and the Chinese green bond market's performance, estimated by the QQ method. Here, *consejp, conseus,* and *conseeu* are the sentiment contagion indicators of Japan, the US, and the EU, respectively; *regbcn* is the green bond returns of China.

5.4.2.   Foreign sentiment contagion and the Japanese green bond market

Table 6 presents the EGACRH regression results on the effects of foreign sentiment contagion on Japan's green bond market's performance.

Table 6. Impact of foreign sentiment contagion on Japanese green bonds.

Panel A: Without control variables

From markets	Constant	Coefficients	LLF	AIC
China	−7.8369*** (1.9941)	0.4811*** (0.1067)	−3908.5	10.032
US	−3.8662* (2.0592)	0.1223** (0.0587)	−3912.6	10.040
EU	−9.6463*** (3.5506)	0.2336*** (0.0853)	−3910.3	10.0339

Notes: This table reports the impact of foreign sentiment contagion between individual and institutional investors on Japan's green bond returns without control variables.

Panel B: With control variables

From markets	Constant	Sentiment	Inflation	Volatility	EPU	LLF	AIC
China	0.3255	0.4086**	−0.1063	−0.0956	1.0552**	−2319.2	5.9671
	(0.7258)	(0.2331)	(0.0952)	(0.3798)	(0.5339)		
US	−0.2424	0.3651*	−0.1541	−0.2873	−0.9207	−1952.6	5.0285
	(1.0026)	(0.2137)	(0.1861)	(0.7514)	(1.1539)		
EU	−3.1895	0.7970*	−0.1953	−0.0475	1.0679	−2135.9	5.5204
	(2.7012)	(0.4396)	(0.1836)	(0.6783)	(0.9062)		

Notes: This table reports the impact of sentiment contagion between individual and institutional investors of foreign markets on green bond returns of Japan with control variables. The inflation rate is the growth rate compared with the same period in the previous year. Volatility and EPU are the natural logarithm of market volatility and economic policy uncertainty indicators, respectively.

Panel B in Table 6 presents the EGARCH model estimates assessing the influence of foreign sentiment contagion on the performance of Japanese green bonds with control variables. The results indicate that sentiment contagion from foreign markets exerts a positive and statistically significant effect on Japanese green bond returns, underscoring the role of cross-border investor sentiment in shaping the dynamics of domestic green finance. The EU's sentiment contagion exhibits the most substantial economic impact among the three foreign countries, with a slope coefficient of 0.7970. This suggests that a one-unit increase in sentiment contagion from the EU is associated with a 0.7970% rise in Japanese green bond returns, which is a substantial effect in the context of bond markets.

Sentiment contagion from China also contributes meaningfully to Japanese green bonds' performance, with a coefficient of 0.4086. This effect mirrors the EU's sentiment contagion influence on China's green bond market, suggesting that the EU is a consistent and influential source of positive sentiment spillovers across major Asian green bond markets.

In contrast, while statistically significant, sentiment contagion from the US yields the most minor economic impact, with a coefficient of 0.3651. This indicates that a one-unit increase in the US sentiment contagion leads to a 0.3651% increase in Japanese green bond returns.

Figure 3 shows the QQ regression results for the impact of foreign sentiment contagion on Japan's green bond market's performance.

Consistent with the QQ regression findings for China, the surface plots for Japan show that the positive effects of foreign sentiment contagion are concentrated in the medium to upper quantiles (0.60–0.95) of Japanese green bond returns. This suggests that during moderate to intense market performance periods, foreign investors' optimism can amplify returns in Japan's green bond market.

Conversely, adverse effects are observed in the lower quantiles (0.20–0.40), indicating that foreign sentiment may exacerbate downturns when the Japanese green bond market is underperforming.

Chinese sentiment contagion and Japanese green bonds   US sentiment contagion and Japanese green bonds
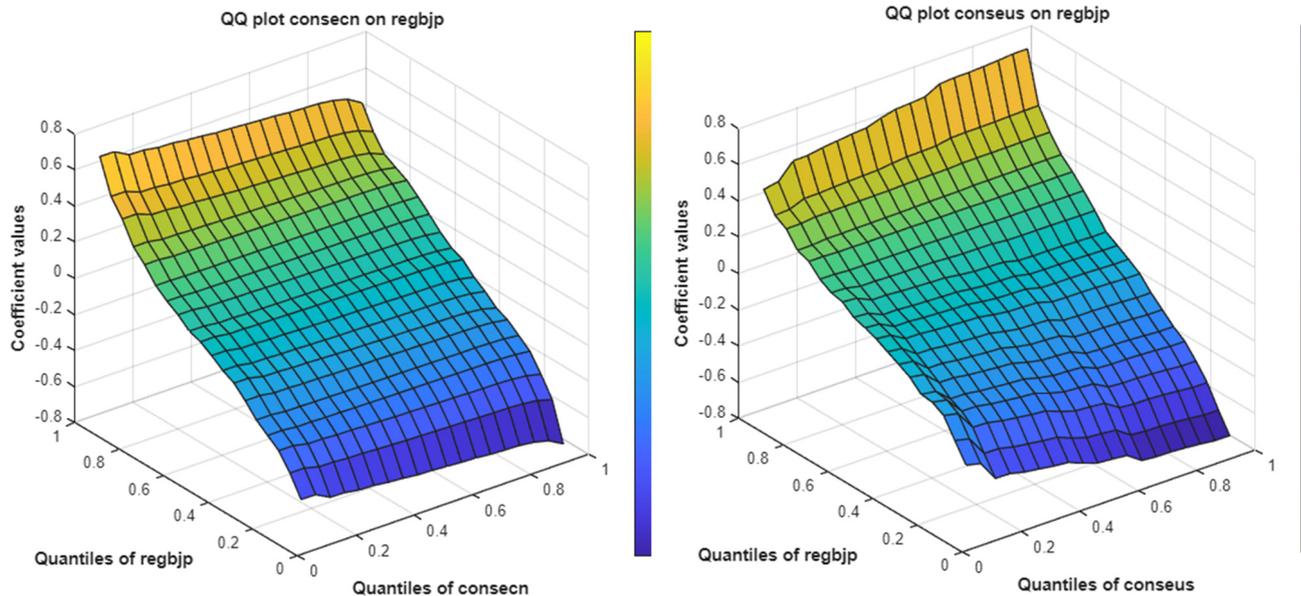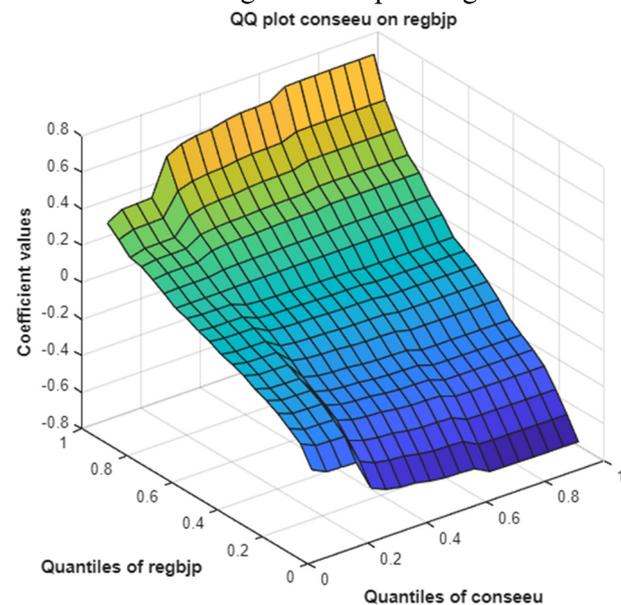

EU sentiment contagion and Japanese green bonds

Figure 3. Surface plot of QQ estimates.

Notes: This figure shows the 3D surface plot of the relationship between foreign sentiment contagion and the Japanese green bond market's performance, estimated by the QQ method. Here, *consecn*, *conseus*, and *conseeu* are the sentiment contagion indicators of China, the US, and the EU, respectively; *regbjp* is the green bond returns of Japan.

Significantly, the source and transmission pattern of sentiment contagion differ across regions. For China, the lower quantiles (0.20–0.40) of sentiment contagion appear to substantially influence

the upper quantiles (0.80–0.95) of Japanese green bond returns, suggesting that even modest sentiment shifts in China can have a pronounced impact during bullish phases in Japan. In contrast, sentiment contagion from the US and EU shows a more direct alignment, where upper quantiles (0.70–0.95) of foreign sentiment contagion correspond to upper quantiles (0.80–0.95) of Japanese green bond returns. This pattern implies that strong investor sentiment in these regions reinforces favorable conditions in Japan's green bond market.

5.4.3.   Foreign sentiment contagion and the US green bond market

The effects of foreign sentiment contagion on the US green bond market's performance are presented in Table 7, using the EGARCH model.

Table 7. Impact of foreign sentiment contagion on US green bonds.

Panel A: Without control variables

From markets	Constant	Coefficients	LLF	AIC
China	13.554*** (1.4955)	−0.9783*** 0.0853)	−4327.2	11.102
Japan	23.062 (14.595)	−0.6886** (0.3461)	−4236.3	10.868
EU	−5.1645 (4.0211)	−0.1997* (0.1197)	−4229.6	10.868

Notes: This table reports the impact of foreign sentiment contagion between individual and institutional investors on the green bond returns of the US without control variables.

Panel B: With control variables

From markets	Constant	Sentiment	Inflation	Volatility	EPU	LLF	AIC
China	−3.0081***	−0.7957**	0.1271*	0.0998*	0.0641**	−2126.9	5.4747
	(1.0724)	(0.3872)	(0.6613)	(0.5706)	(0.2573)		
Japan	−3.0121	−0.6802*	0.7472	0.5974	0.0718	−1994.1	5.1346
	(5.0359)	(1.3286)	(0.5739)	(0.5755)	(0.2509)		
EU	0.5617	−0.2778*	0.6313	0.5288	0.0501	−1968.8	5.0701
	(2.2139)	(0.6350)	(0.5508)	(0.5641)	(0.2465)		

Notes: This table reports the impact of sentiment contagion between individual and institutional investors of foreign markets on the green bond returns of the US with control variables. The inflation rate is the growth rate compared with the same period in the previous year. Volatility and EPU are the natural logarithm of market volatility and economic policy uncertainty indicators, respectively.

The results reveal a statistically significant but negative relationship, indicating that rising investor sentiment in foreign markets, contrary to expectations, dampens the performance of the US green bond market. This finding starkly contrasts the positive contagion effects observed in China and Japan, suggesting unique behavioral or structural dynamics in the US green bond market.

Among the three foreign economies, Chinese sentiment contagion exerts the most pronounced negative impact, with a coefficient of −0.7957. This implies that a one-unit increase in sentiment contagion from China leads to a 0.78% decline in US green bond returns, a substantial effect in fixed-income markets. This may reflect competitive pressures, divergent policy orientations, or

investor reallocations away from US green assets in response to positive developments in China's green finance sector.

Japanese sentiment contagion also contributes negatively, with a coefficient of −0.6802, suggesting that a one-unit increase in Japanese sentiment is associated with a 0.68% reduction in US green bond returns. While smaller than China's, this effect remains economically significant and may indicate regional capital flow dynamics or sentiment-driven portfolio rebalancing.

The EU's sentiment contagion shows the least negative impact, with a coefficient of −0.2778, corresponding to a 0.28% decline in US green bond returns for each unit of increase in EU sentiment. Although modest, this effect points to a consistent pattern of inverse sentiment transmission from foreign markets to the US.

Figure 4 provides the surface plots based on the QQ-estimated results on the relationship between foreign sentiment contagion and the US green bonds' performance.

The QQ surface plots provide further insight into the relationship between foreign sentiment contagion and US green bond returns. While the EGARCH model's results indicate that the average effect of foreign sentiment contagion is adverse, the QQ analysis reveals a more nuanced pattern. Specifically, positive impacts are observed at the upper quantiles (0.80–0.95) of US green bond returns, suggesting that foreign sentiment can enhance performance under favorable market conditions.

The source and distribution of contagion effects vary across regions. The lower quantiles (0.25–0.45) of Chinese and Japanese sentiment contagion exert the most substantial positive influence on the upper quantiles of US green bond returns, indicating that even modest optimism in these markets can reinforce bullish trends in the US green bond sector. In contrast, the upper quantiles (0.70–0.95) of EU sentiment contagion are most strongly associated with the upper quantiles of US returns, suggesting that strong investor sentiment in the EU aligns with high-return conditions in the US market.
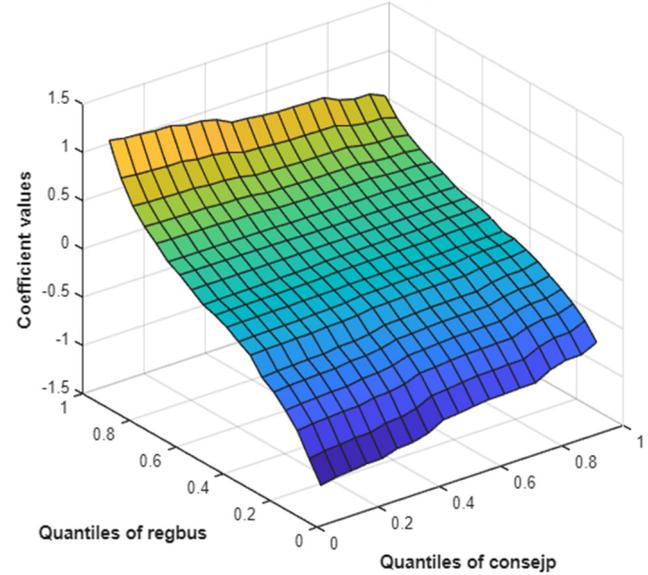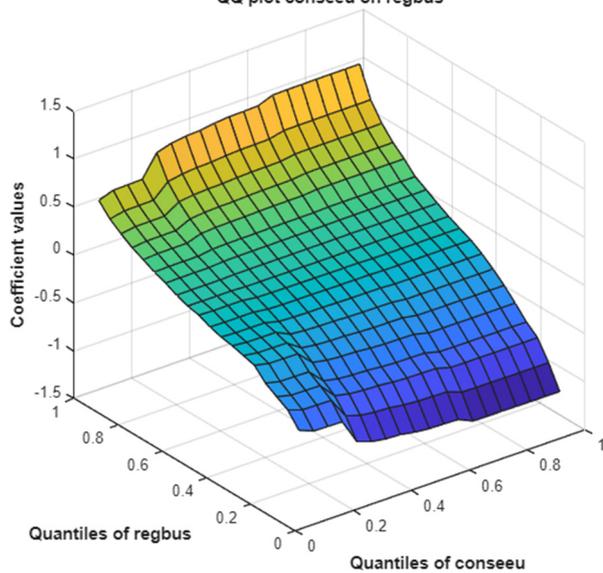
Chinese sentiment contagion and US green bonds
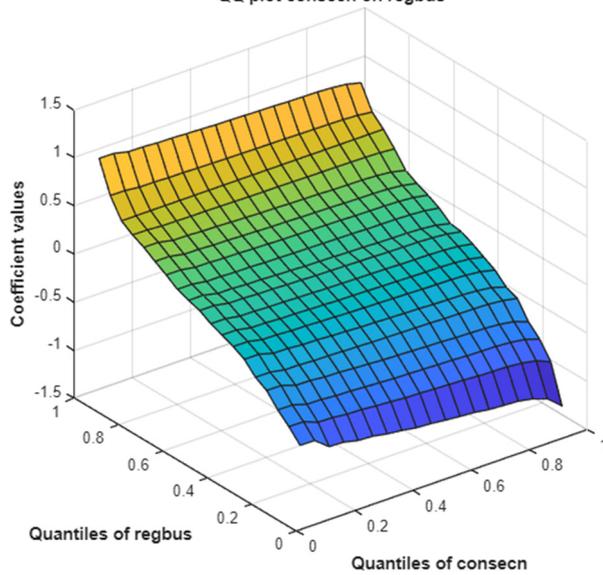
Japanese sentiment contagion and US green bonds

EU sentiment contagion and US green bonds

Figure 4. Surface plot of QQ estimates.

Notes: This figure shows the 3D surface plot of the relationship between foreign sentiment contagion and the US green bond market's performance, estimated by the QQ method. Here, *consecn, consejp,* and *conseeu* are the sentiment contagion indicators of China, Japan, and the EU, respectively; *regbus* is the green bond returns of the US.

5.4.4. Foreign sentiment contagion and the EU green bond market

Table 8 shows the findings from the EGARCH model of the impact of foreign sentiment contagion on the EU green bond market's performance.

Table 8. Impact of foreign sentiment contagion on EU green bonds.

Panel A: Without control variables

From markets	Constant	Coefficients	LLF	AIC
China	−7.0401*** (2.4908)	0.4194*** (0.1184)	−3906.6	10.024
Japan	−24.818*** (3.3863)	0.5815*** (0.0866)	−4046.5	10.382
US	−2.5906 (1.7928)	0.1577*** (0.0486)	−3926.9	10.076

Notes: This table reports the impact of foreign sentiment contagion between individual and institutional investors on the green bond returns of the EU without control variables.

Panel B: With control variables

| From markets	Constant	Sentiment	Inflation	Volatility	EPU	LLF	AIC
China	−0.1305	0.4162***	0.1374***	0.0137***	−0.0197	−2262.4	5.8218
	(0.2696)	(0.0991)	(0.0815)	(0.2006)	(0.0363)		
Japan	−3.5460	0.9043*	0.1926	0.5124	−0.1114	−1867.3	4.8221
	(4.1848)	(1.1432)	(0.2523)	(0.5430)	(0.5878)		
US	−1.2478**	0.6656***	0.5616***	0.1435***	−0.0981*	−2132.2	5.5006
	(0.6105)	(0.1481)	(0.2132)	(0.4813)	(0.5059)		

Notes: This table reports the impact of sentiment contagion between individual and institutional investors of foreign markets on the green bond returns of the EU with control variables. The inflation rate is the growth rate compared with the same period in the previous year. Volatility and EPU are the natural logarithms of market volatility and economic policy uncertainty indicators, respectively.

The results indicate that foreign investor sentiment exerts a positive and statistically significant impact on EU green bond returns, consistent with the patterns observed in the Chinese and Japanese markets.

Japan's sentiment contagion demonstrates the most substantial effect among the three foreign economies, with a one-unit increase in Japanese sentiment being associated with a 0.90% rise in the EU's green bond returns. This substantial impact may reflect strong financial linkages and shared investor behavior between the EU and Japan in the green finance domain. The US sentiment contagion also contributes meaningfully, with a coefficient of 0.6656, suggesting that optimism among the U.S. investors positively influences EU green bonds' performance. Although the Chinese sentiment contagion has the smallest estimated coefficient (0.4162), it remains statistically significant and economically relevant. This may be driven by China's growing role in global sustainable finance and its influence on international ESG investment flows. These findings suggest that the EU green bond market responds strongly to foreign investor sentiment, particularly from Japan and the US.

Figure 5 plots the QQ regression results of the impact of foreign sentiment contagion on the EU's green bond returns at different quantiles.

Chinese sentiment contagion and EU green bonds
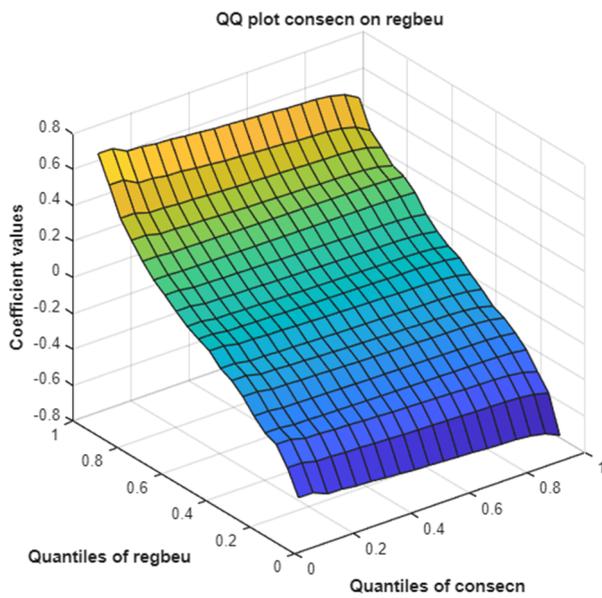
Japanese sentiment contagion and EU green bonds
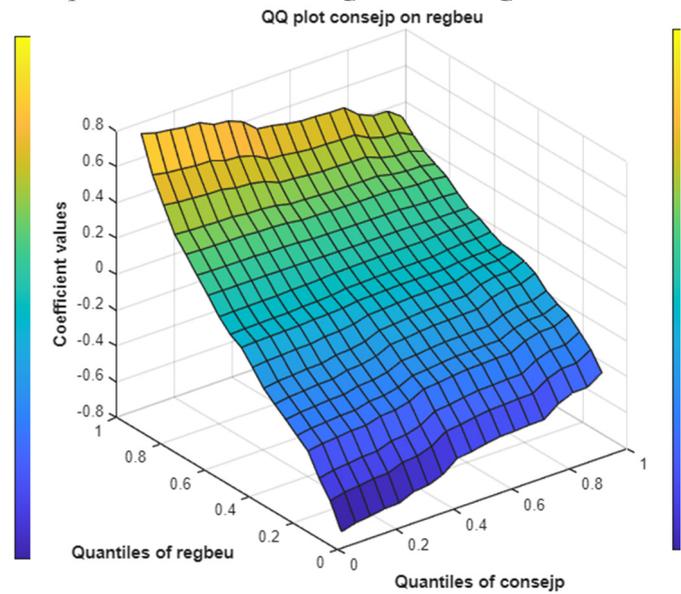
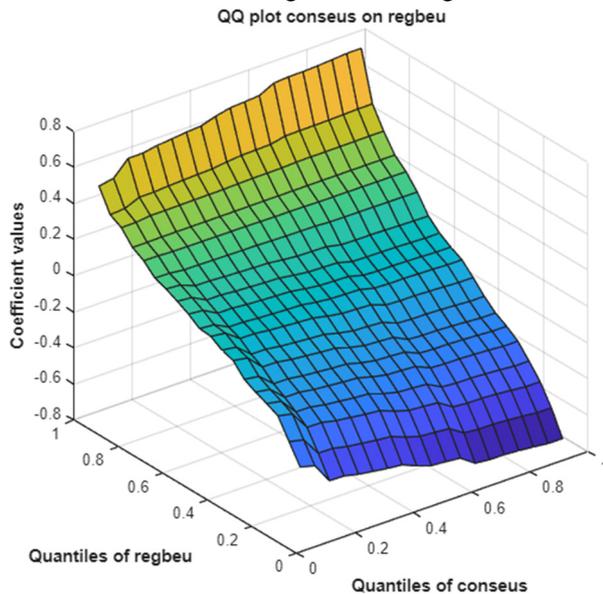The US sentiment contagion and EU green bonds

Figure 5. Surface plot of QQ estimates.

Notes: This figure shows the 3D surface plot of the relationship between foreign sentiment contagion and the EU green bond market's performance, estimated by the QQ method. Here, *consecn*, *consejp*, and *conseus* are the sentiment contagion indicators for China, Japan, and the US; *regbeu* is green bond returns of the EU.

Similar to the patterns observed in the US market, the QQ plots for the EU show that positive impacts are concentrated in the medium to upper quantiles (0.60–0.95) of EU green bond returns. This suggests that foreign investor sentiment enhances EU green bonds' performance during favorable market conditions, reinforcing upward trends when the returns are already elevated.

The distribution of contagion effects differs across regions. The lower quantiles (0.25–0.45) of Chinese and Japanese sentiment contagion exert the most substantial positive influence on the upper quantiles of EU green bond returns. This indicates that even moderate optimism in these markets can

significantly boost the EU's performance during bullish phases. In contrast, the upper quantiles (0.77–0.95) of the US sentiment contagion are most strongly associated with the upper quantiles of the EU's returns, suggesting that strong investor sentiment in the US aligns with high-return conditions in the EU market.

6. Discussion of the results

In this section, we discuss the abovementioned findings of our research. Given the sentiment contagion between individual and institutional investors presented in Section 5.2, we only discuss how it affects the domestic and foreign green bond markets of China, Japan, the US, and the EU.

6.1. The impact of domestic sentiment contagion on green bond markets' performance

Our findings, derived from the EGARCH model (Table 4, Panel B) and supported by QQ estimations (Figure 1), reveal that domestic sentiment contagion plays a significant and heterogeneous role in shaping green bond markets' performance across China, Japan, the US, and the EU.

The EU exhibits the strongest positive impact among the four markets, with a contagion coefficient of 1.1394, followed by the Japan at 0.9685. These effects are economically meaningful compared with their respective average green bond returns of −0.0166% and −0.0279%. The pronounced influence of sentiment contagion in these regions aligns with their high levels of co-movement between individual and institutional investor sentiment, as reflected in their TSI values of 82.27% for the EU and 77.21% for Japan. The dominance of positive sentiment effects in the QQ plots further corroborates these findings. This suggests that in both Japan and the EU, investors actively incorporate the expected sentiment of other investor groups into their decision-making processes, resulting in synchronized behavior that positively correlates with green bonds' performance.

In contrast, China's sentiment contagion effect is relatively mild, with a coefficient of 0.2558. While this impact is still notable relative to China's average green bond return of 0.0144%, it is the smallest among the four markets. This outcome is consistent with China's low TSI value of 34.18%, indicating that investor sentiment in China is more fragmented, with individual and institutional investors forming expectations more independently. Nevertheless, when contagion does occur, it still contributes positively to green bonds' performance, albeit to a lesser extent.

The US presents a unique case, where sentiment contagion negatively impacts green bond returns, with a coefficient of −0.0916. This result is particularly striking, given the US's moderate TSI of 59.98% and its leading position in global green bond trading volumes. The adverse effect of contagious sentiment on US green bond returns is consistent with the research of Baker et al. (2012) but contrary to that of Todd and Shuming (2017), who shed light on this nexus across developed stock markets, including in the US. The contrarian predictor of sentiment contagion of the US green bond returns may reflect a behavioral dynamic in which increased optimism and sentiment alignment among investor groups lead to portfolio rebalancing, with investors reallocating funds from green bonds to assets perceived as offering higher returns or lower risk. This behavior underscores the complexity of sentiment-driven investment decisions in mature and highly liquid markets like the US.

Given the absence of prior evidence from green bond or conventional bond markets, the sentiment contagion-stock market relationship in previous literature serves as a natural benchmark for understanding our results. Accordingly, our findings of the significant impact of contagious sentiment on the returns of green bond markets are broadly consistent with extensive evidence from stock markets, supported by Zhou & Huang (2020); Gong et al. (2022); Zhou et al. (2023); Yang & Xiong (2024) for China. Thus, our results extend the literature by demonstrating that a similar sentiment contagion operates in the green bond markets, despite their fixed-income structure and sustainability orientation.

In addition to the sentiment contagion literature, our results are also consistent with growing evidence that investor sentiment plays a significant role in the pricing of green bonds, documented by Bouteska et al. (2024); Gao & Liu (2024); Man et al. (2024); Le et al. (2025). Consequently, this study reinforces this research strand by showing that sentiment not only affects green bond markets directly but also propagates across investor groups, suggesting an additional channel through which sentiment-driven pricing effects emerge in green bond markets. The significant spillover between domestic institutional and individual investor sentiment reflects the operation of approximate rationality, as described by Simon (1955), within a local market structure. When investors face limited information or ambiguity, they simplify decision-making by inferring signals from each other's sentiment rather than fully processing the fundamentals. This satisficing behavior allows domestic sentiment to diffuse quickly and influence domestic green bond returns.

In a broader perspective, the existence of sentiment transmission between individual and institutional investors in our research provides empirical evidence for theories of emotional contagion and behavioral finance, which argue that emotions or opinions can spread across market participants and eventually influence asset prices. Our results also align with the conceptual foundations of SRI, in which investment decisions reflect not only financial interests but also environmental and social considerations.

The differences in the effect of domestic sentiment contagion on green bond returns across these four markets may result from the diversified features in their market structure, investor composition, and regulatory frameworks. For instance, in Japan and the EU, green bond markets are predominantly institution-driven and highly regulated, with strong alignment between investors' sustainable preferences and portfolio allocation decisions, leading to a stronger positive association between sentiment contagion and green bond returns. By contrast, in China, the green bond market is characterized by a more segmented institutional and policy-driven environment, reflected by the prominent role of state-owned issuers. These structural features limit the transmission of information between individual and institutional investors, consequently weakening the impact of sentiment contagion on its green bond returns. The US market displays a distinct pattern with high liquidity and diversified investor participation. In this environment, it appears that stronger sentiment contagion between investor groups may trigger reallocation away from green bonds toward alternative assets rather than reinforcing green bond demand. Thus, sentiment spillovers are more likely to generate substitution effects than synchronized buying pressure, leading to a negative relationship between sentiment contagion and domestic green bond returns.

6.2. The impact of foreign sentiment contagion on green bond markets' performance

To provide a more comprehensive understanding of how sentiment contagion influences green bond markets' performance, we extend our analysis beyond domestic markets to include cross-border dynamics. In light of increasing capital liberalization and the internationalization of investment portfolios, investors are increasingly engaging in green investments across borders. This trend raises the possibility of foreign sentiment contagion, whereby the alignment of sentiment between individual and institutional investors in one country affects green bond returns in another.

The results from the EGARCH models (Panels B of Tables 5–8) and QQ plots (Figures 2–5) reveal that the effects of foreign sentiment contagion are more nuanced and complex than those observed in domestic contexts. Specifically, we identify three patterns in how sentiment contagion originating from one country influences green bond returns in others.

First, China and Japan exhibit stronger outbound contagion effects, meaning their investor sentiment significantly influences green bond returns in other countries more than foreign sentiment affects their own markets. This suggests that Asian sentiment contagion exerts a more pronounced influence on Western green bond markets. For instance, while a one-unit increase in foreign sentiment contagion corresponds to a 0.1407–0.5005% change in Chinese green bond returns, the same increase in Chinese sentiment contagion is associated with a 0.4612% increase or a 0.7957% decrease in other countries' green bond returns. Similarly, Japan's green bond returns respond to foreign sentiment contagion with a 0.3651–0.7970% increase. In contrast, Japanese sentiment contagion leads to 0.9043% increases or 0.6802% decreases in foreign markets.

This asymmetry is particularly noteworthy, given that China and Japan's green bond markets are relatively less mature and smaller than those of the US and EU. A plausible explanation is that Asian investors are more actively engaged in Western green bond markets, especially in the US, exerting greater influence as foreign participants. Conversely, China and Japan's green bond markets are more domestically oriented, limiting the impact of foreign sentiment contagion on their performance.

Second, the EU and Japan exert the most decisive influence on foreign green bond returns. These findings are consistent with their strong sentiment contagion between individual and institutional investors. Explicitly, the TSI values of the EU and Japan are 77.21% and 82.27%, respectively, further strengthening the significant impact of contagious sentiment on shaping the performance of green bond markets.

Third, the US green bond market displays a unique pattern, with adverse foreign sentiment contagion effects. These impacts are substantial, with estimated coefficients ranging from −0.2778 to −0.7957. This counterintuitive result may stem from two factors. On one hand, when foreign investors exhibit heightened optimism and sentiment alignment, they may reallocate their portfolios toward domestic assets or other international markets, reducing demand for the US green bonds. On the other hand, the US financial market's openness and market-oriented nature attract a significant number of foreign investors, making it more susceptible to external sentiment shifts.

Among the three foreign markets, the sentiment contagion from Chinese and Japanese investors has the most significant influence on US green bond returns. Specifically, a 1% increase in their sentiment indices is associated with 0.79% and 0.68% declines in the returns of US green bonds, respectively. The negative sign and large magnitude of these coefficients reveals a striking result that

sentiment contagion from less liquid and mature markets substantially directs the performance of the leading green bond markets around the world.

There are several ways to explain this finding. First, Tsai (2017) documents that investors in emerging markets, particularly institutional investors, exhibit nonherding behavior in favorable market conditions. In the context of Japanese and Chinese investors, they may also exhibit contrarian traits when trading US green bonds. Accordingly, as the sentiment of their individual and institutional investors is more aligned in optimistic periods, rather than purchasing more foreign assets, they may reallocate their portfolios toward domestic assets or other international markets (Baker et al., 2012), reducing demand for US green bonds. Additionally, our results to date confirm the significant impact of sentiment contagion on green bond returns across markets. Given that evidence, when investors trade according to sentiment rather than genuine information or liquidity demand, assets can be temporarily overpriced or underpriced (Tsai, 2017). Thus, once that sentiment-driven pressure fades, prices of overvalued assets may be corrected to their fundamental values. This sentiment's disappearance further supports the concern that because the contrarian behavior of Chinese and Japanese investors exists, they may lose their sentiment regarding the US market, driving its asset prices, including green bonds, down.

Before Tsai (2017) and Baker et al. (2012) also documented the contrarian behavior of investors across different stock markets, including the US. The result shows that the negative relationship between foreign investor sentiment and stock returns is primarily driven by cross-border sentiment contagion, stemming from capital movements between countries. Following Baker et al. (2012), we test whether capital flows are a key mechanism underlying this association. In this context, because we focus on the negative impact of Asian sentiment on US green bond returns, and due to constraints on the data on other countries' capital flows, we only test sentiment contagion from China and Japan to US green bonds. Subsequently, we obtained data on capital flows from the US to China and Japan from the Treasury Bulletin for the period from January 2022 to December 2024. Because the data are monthly, we again use the linear interpolation of Bethke et al. (2017); Wang & Duxbury (2021). Capital flows from the US to China and Japan are scaled by each country's total market capitalization (Baker et al., 2012), and daily data were retrieved from Bloomberg. Despite mentioning capital flows, our primary interest is the interaction between foreign sentiment contagion and capital flows to validate the concern that this impact results from capital reallocation. Table 9 reports the EGARCH estimates of the impact of Chinese and Japanese sentiment contagion, together with the capital flows, on the returns of US green bonds.

Table 9. Impact of Asian sentiment contagion on US green bonds and the interaction with capital flows.

From markets	Constant	Sentiment	Capital	Sentiment*Capital	LLF	AIC
China	0.8418***	−0.9390***	−0.2244***	0.4840***	−2288.1	6.0425
	(0.6802)	(0.1441)	(0.2000)	(0.0434)		
Japan	3.0322	−0.9334**	0.7289	0.0001	−2292.6	6.0782
	(13.623)	(0.4278)	(0.4718)	(0.0773)		

Notes: This table reports the impact of sentiment contagion between individual and institutional investors of Asian markets on US green bond returns and its interaction with the capital variable.

If we add the interaction between US portfolio exposure and foreign sentiment contagion, the sentiment coefficients for both China and Japan are statistically significant and more negative than the main results reported in Panel B of Table 7, further strengthening our findings of the adverse impact of Asian sentiment contagion on US green bond returns. However, the impact of the interaction variables varies across the two countries. Specifically, in the Chinese context, the parameter is significantly positive (0.484), indicating that it attenuates the adverse effects of sentiment contagion between individual and institutional Chinese investors on US green bond returns. This suggests that a higher financial integration allows US investors to partially absorb sentiment shocks from China, serving as a buffering mechanism for sentiment spillovers. Meanwhile, the coefficient for Japan is relatively small and insignificant (0.0001), indicating that sentiment contagion is still the primary driver of US green bond returns.

The cross-border sentiment contagion found by Baker et al. (2012) may raise the question of whether the adverse impact of Asian sentiment contagion on US green bonds originates from the synchronized global reactions to macroshocks. To gain a more comprehensive understanding of this effect in our research, in addition to incorporating the interaction with capital, we re-estimate the research model using macroeconomic variables for China and Japan, including the inflation rate, the market volatility index, and the EPU index, as control variables. Table 10 presents the EGARCH regression on the impact of Asian sentiment contagion and macroeconomic factors on US green bonds.

Table 10. Impact of Asian sentiment contagion and macroeconomic factors on the US green bonds

From markets	Constant	Sentiment	Inflation	Volatility	EPU	LLF	AIC
China	1.5966*	−0.8043**	0.3358**	0.4738	−0.9346	−2016.3	5.3834
	(0.8359)	(0.3852)	(0.1456)	(0.3258)	(0.5877)		
Japan	0.8301	−0.8428***	−0.3441***	0.0688	0.0402***	−2362.1	6.0875
	(1.0946)	(0.2620)	(0.5561)	(0.1304)	(0.0406)		

Notes: This table reports the impact of sentiment contagion between individual and institutional investors of Asian markets and their macroeconomic variables on the US green bond returns.

In both the Chinese and Japanese specifications, the coefficients of sentiment remain significantly negative after controlling for these fundamentals. While specific macroeconomic channels (for instance, Chinese inflation and Japanese EPU) exhibit some co-movement with US green bonds, they do not capture the sentiment contagion effect. Hence, sentiment contagion still

constitutes an independent transmission channel rather than being a byproduct of synchronized macroeconomic shocks.

Our evidence of the significant impact of foreign sentiment contagion on green bond markets is consistent with the existing literature and related theoretical frameworks in several important respects. First, it aligns with prior research such as Baker et al. (2012); Todd & Shuming (2017); Hudson & Green (2015), which shows that sentiment is contagious not only across investor groups but also across national boundaries, influencing asset prices in foreign markets. These studies, primarily focused on equity markets, suggest that international information flows and correlated investor expectations facilitate cross-border sentiment spillovers. Our findings extend this research stream by showing that such cross-market sentiment contagion is also present in the green bond market.

Second, these results provide further empirical support for behavioral finance and prospect theories stating that market participants incorporate psychological and emotional factors into their financial decision-making. The cross-border sentiment contagion observed in our study suggests that green bond markets are shaped not only by the spillovers of domestic investor sentiment but also by foreign ones, reinforcing the view that SRI-related assets are inherently exposed to the dynamics of cross-country sentiment. The findings are also consistent with the notion of "approximate rationality" introduced by Simon (1955). Explicitly, cross-border investors often lack complete information about foreign fundamentals and face high transaction costs; hence, they rely on sentiment indicators as simplified heuristics. This creates spillovers driven by investors' satisfactory decision rules in the face of global uncertainty and asymmetric information, rather than by entirely rational price discovery. Such behavior is especially relevant when markets differ in their transparency and investor composition.

7.   Robustness checks

In this section, we conduct robustness tests by utilizing the net total directional spillover index estimated by the TVP-VAR model as an alternative proxy of the contagion between the sentiment of individual and institutional investors. For the reasons mentioned above, in this section, we do not present the estimation from the QQ model

In Section 4.2.1, we calculated the total spillover index using a TVP-VAR model to proxy for sentiment contagion between individual and institutional investors, which serves as the basis for our primary analysis. This measure may raise concerns about whether this index fully captures the contagion among sentiment indicators. Hence, continuing with this model, we estimate the net total directional spillover index (NET) and utilize it as an additional proxy for sentiment contagion, which involves three steps.

Because we have only two variables (individual and institutional investors' sentiment), the measurement creates a two-node system whose NET values have the same magnitude but opposite signs. Therefore, we adopt the absolute value of either NET index to proxy for sentiment contagion.

The impact of sentiment contagion measured by net total directional spillovers on the returns of green bonds for domestic and foreign markets is reported in Tables 11 and 12.

The signs and statistical significance of the sentiment parameters presented in Tables 11 and 12 further strengthen our main findings, which indicate that sentiment contagion has important effects on both domestic and foreign green bond markets. Notably, the results remain qualitatively

unchanged when sentiment contagion is measured using net total directional spillovers instead of total spillovers, confirming that our conclusions are robust to alternative directional decompositions of sentiment alignment.

Table 11. Impact of domestic sentiment contagion on green bond return using NET values.

Markets	Constant	Sentiment	LLF	AIC
China	4.8776*** (1.5517)	0.1478*** (0.0452)	−2484.7	6.3861
Japan	−3.9347** (1.8494)	0.7451* (0.4310)	−3901.7	10.0120
US	1.6902*** (0.4193)	−0.3172*** (0.1193)	−2889.7	10.9668
EU	−4.4006*** (0.5186)	0.7661*** (0.1959)	−4047.9	10.3916

Notes: This table shows the impact of net total directional spillovers between the sentiment of domestic individual and institutional investors on green bond returns.

Table 12. Impact of domestic sentiment contagion on green bond return using NET values.

	Constant	Sentiment	LLF	AIC
From markets	To China			
Japan	1.1546*** (0.1273)	0.0576** (0.0315)	−2441.9	6.2788
US	1.2152*** (0.2875)	0.001* (0.1388)	−2376.4	6.1163
EU	1.3901*** (0.2380)	0.2245*** (0.0837)	−2635.7	6.8017
From markets	To Japan			
China	−4.2965** (1.7274)	0.5940** (0.2490)	−3901.2	10.0108
US	2.3221*** (0.5439)	0.3543* (0.3621)	−4046.2	10.3846
EU	1.0218 (3.7528)	0.4254* (0.6115)	−3904.3	10.0213
From markets	To the US			
China	0.5717** (0.2614)	−0.5972*** (0.1352)	−4327.3	11.126
Japan	−2.7957** (1.3165)	−0.1390* (0.0860)	−4328.0	11.1309
EU	4.4349*** (1.9898)	−0.0971* (0.2237)	−4325.3	11.109
From markets	To the EU			
China	−1.8338 (2.4168)	0.8592*** (0.2230)	−3909.0	10.038
Japan	−2.4332 (1.7478)	0.9699*** (0.3707)	−3908.3	10.034
US	1.5044*** (0.2638)	0.3119* (0.2638)	−4052.6	10.406

Notes: This table shows the impact of net total directional spillovers between the sentiment of foreign individual and institutional investors on green bond returns.

8.   Conclusion and implications

The existence of sentiment contagion among individual and institutional investors has been documented in psychology and behavioral finance literature. Nevertheless, its influence on green financial instruments, particularly green bonds, remains insufficiently explored. To address this gap,

this study constructs a sentiment contagion index using the TVP-VAR model, a state-of-the-art approach for capturing dynamic connectedness. The analysis covers four major markets, namely China, Japan, the US, and the EU, from 3 January 2022 to 31 December 2024.

Using these sentiment contagion indicators, we examine their impact on green bond markets' performance in two dimensions. First, we assess the domestic effects, analyzing how a country's sentiment contagion influences its green bond returns. Second, we investigate the cross-border effects, exploring whether sentiment contagion in one country affects green bond performance in other countries. These relationships are evaluated with the EGARCH model to estimate the average effects and the QQ regression to capture distributional dynamics.

Our findings reveal three key insights. The TVP-VAR model confirms the presence of contagious sentiment between individual and institutional investors, though the intensity varies across markets. China exhibits the lowest level of sentiment contagion, the US shows moderate contagion, and Japan and the EU demonstrate the highest levels. These differences reflect varying degrees of investor co-movement in expectation formation, consistent with behavioral finance theories on herding and correlated beliefs.

When linking these sentiment contagion measures to green bond returns, the effects are significant but heterogeneous. In China, the low contagion corresponds with a mild positive impact. Higher contagion levels in Japan and the EU substantially enhance green bonds' performance, suggesting that synchronous investor sentiment positively influences the market outcomes. In contrast, the US presents a unique case where sentiment contagion has a negative and statistically significant effect on green bond returns.

Cross-border sentiment contagion effects are more complex. Despite having the lowest domestic contagion, China's investor sentiment strongly influences foreign green bond markets, particularly in Japan, the US, and the EU. Notably, foreign sentiment contagion consistently and negatively affects US green bond returns, highlighting the sensitivity of the US market to external investor sentiment. Moreover, sentiment contagion originating from Asian markets appears to have a greater impact on Western green bonds' performance than the reverse.

The QQ regression results reinforce these findings by illustrating how sentiment contagion impacts green bond returns across different quantiles. Specifically, positive effects are concentrated in the medium and upper quantiles of return distributions, while contagion levels vary across markets.

Our research findings offer valuable policy implications to green bond market regulators. First, knowing the variation in sentiment contagion among countries helps regulators develop appropriate supervising methods. Specifically, the high sentiment contagion observed in advanced markets such as Japan, the US, and the EU suggests that investor sentiment can easily propagate across investor groups, potentially amplifying market volatility during periods of stress. This underscores the need for robust market surveillance systems and timely communication strategies to manage sentiment-driven risks. For instance, regulators should construct sentiment monitoring frameworks by incorporating contagious sentiment indicators into existing market surveillance dashboards. Such a framework should (i) quantify investor sentiment daily using ESG-tagged news, social media texts, and order-flow indicators that are relevant to green bonds; (ii) classify market conditions into optimistic, neutral, and pessimistic states through standardized and cross-market scoring systems; and (iii) establish numeric sentiment thresholds for different investor groups (individual and institutional). Thereby, they could

track abnormal changes in sentiment spillovers and activate enhanced disclosure or trading activity assessments once sentiment contagion exceeds specified thresholds. In contrast, the low sentiment contagion in China indicates a more segmented market structure, which may offer some insulation from systemic sentiment shocks but also suggests limited efficiency in information transmission. To address these issues, Chinese regulators should focus on improving information flows by publicizing the reports on the use of proceeds, standardizing green bond certification, and expanding institutional access channels for individual investors. Additionally, our results show that in most cases, individual investor sentiment is the net transmitter while institutional sentiment is the net receiver. Therefore, regulators may also consider initiating financial literacy or investor education programs and increasing the transparency of market information to help individual investors make more informed decisions, reducing the likelihood of herd behavior and panic transmission.

Second, the significant and heterogeneous effects of domestic sentiment contagion on green bond returns suggest that regulators should broaden their analytical perspective beyond traditional supply-side considerations. Specifically, demand-side dynamics, particularly the interaction between individual and institutional investor sentiment, should be recognized as a critical factor influencing green bond markets' performance. Policymakers are therefore encouraged to treat sentiment contagion as a potential channel for risk transmission and incorporate it into regulatory frameworks to enhance market stability. There is no universally accepted methodology for measuring investor sentiment or sentiment contagion, particularly in the context of ESG-oriented financial instruments. Researchers and regulators rely on heterogeneous proxies such as investor surveys, text-based indicators, or volatility indices, leading to inconsistent measurement and limited comparability across studies and countries. Given the demonstrated importance of sentiment contagion in shaping green bond returns, we recommend that national regulatory bodies develop official, transparent, and consistently constructed investor sentiment and sentiment contagion indices. Investor sentiment indicators for green bond markets should be constructed to capture the multidimensional nature of sentiment formation explicitly. In particular, regulators should develop sentiment measures that: (i) differentiate investor groups (individual and institutional), (ii) separate investor geographies (domestic and foreign), and (iii) incorporate both direct sentiments (such as survey-based expectations and ESG-relevant textual sentiment from news and disclosures) and indirect sentiments (such as trading volume, market liquidity, and portfolio reallocation behavior). These indicators should be publicly available, regularly updated, and formally incorporated into market monitoring and regulation frameworks. Furthermore, their construction should explicitly distinguish between conventional and sustainable financial assets to reflect differences in investment motives and sentiment formation. Moreover, the effects of sentiment contagion are not uniform across markets. For instance, domestic sentiment contagion negatively influences green bond returns in the US, underscoring the need for tailored regulatory responses. As such, when designing policies to stabilize domestic green bond markets, regulators should account for market-specific characteristics and implement measures that mitigate excessive herd behavior and sentiment-driven volatility.

Third, foreign sentiment contagion's significant and varied effects on green bond returns have important implications for regulators in both emerging and advanced markets. In addition to domestic sentiment dynamics, regulatory frameworks should explicitly account for the influence of foreign sentiment contagion. For instance, although China exhibits the lowest level of sentiment contagion,

that contagion exerts the most decisive influence on the green bond returns of other countries. This suggests that regulators in more developed markets should monitor the herding behavior of foreign investors, particularly those from China, to mitigate volatility during periods of heightened uncertainty. The US green bond market, in particular, is susceptible to foreign sentiment contagion, underscoring the need for targeted measures to reduce the transmission of external sentiment-driven risks. Achieving comprehensive and resilient green bond regulation will require enhanced international cooperation, including developing standardized sentiment contagion indicators and coordinated stability mechanisms across jurisdictions. Specifically, we recommend cross-country collaboration in developing standardized and internationally comparable indicators of investor sentiment and sentiment contagion. Such indicators should be jointly constructed, transparently documented, and consistently applied across markets to leverage cross-country monitoring and policy coordination. Again, separate indicators should be developed for conventional and ESG-oriented financial instruments to account for differences in investment motives and sentiment dynamics.

The findings of this study offer valuable insights for green bond investors seeking to refine their investment strategies. First, the varying levels of sentiment contagion across markets provide a lens through which investors can assess the degree of sentiment alignment among market participants and a signal to realize potential sentiment-driven risks. In markets such as China, where sentiment contagion is relatively low, investors operate in a more segmented environment, with individual and institutional sentiment forming independently. In contrast, Japan and the EU exhibit higher levels of sentiment contagion, allowing investors to infer market expectations by observing other group's sentiment behavior.

Second, the significance and asymmetry of sentiment contagion effects, domestically and across borders, suggest that investors can utilize these dynamics to inform portfolio allocation and risk management. For instance, investors in Asian markets, particularly China, should recognize that their sentiment contagion disproportionately influences green bond returns in advanced markets such as the US and the EU. This insight may encourage them to anchor their investment decisions in these more developed markets. Conversely, given the negative impact of foreign sentiment contagion on US green bond returns, investors exposed to the US market should adopt strategies that mitigate external sentiment-driven risks, such as diversification or dynamic hedging.

While this study offers meaningful insights and practical recommendations for green bond regulators and investors, it has limitations. First, although widely accepted proxies for individual and institutional investor sentiment are used to construct sentiment contagion indicators, these measures may not fully capture the nuanced psychological and behavioral dimensions specific to SRI, such as green bonds. This underscores the need for future research to develop standardized sentiment metrics tailored to the context of green finance. Second, data availability imposed constraints on the analysis's temporal and geographic scope. For example, Japan's green bond index data are only available from October 2021 onward, limiting our ability to examine sentiment contagion effects during earlier periods of market stress, such as the COVID-19 pandemic. Additionally, the limited availability of sentiment data across investor groups restricts the inclusion of other regions or country-level analyses. Lastly, our research is limited by the monthly frequency of sentiment data, which does not fully align with the daily green bond return series. While the linear interpolation approach ensures temporal alignment with the daily green bond return data, it mechanically smooths away any high-frequency

variation that may reflect genuine sentiment dynamics. As Engle et al. (2013) highlight, combining data sampled at different frequencies inevitably results in a loss of information from the higher-frequency series. Additionally, daily interpolation artificially imposes linear paths between monthly sentiment observations, thereby eliminating the inherent nature of sentiment data that characterizes real-world behavioral reactions. Consequently, it may underestimate the actual behavioral transmission mechanism between investor groups, the effects of sentiment contagion on the returns, and the frequency-domain analysis of the relationship. As green bond markets evolve and data coverage improves, future studies will be better positioned to explore these dimensions in greater depth, thereby enriching the understanding of sentiment's dynamics across diverse market environments.

Author contributions

Thuy Duong Le: Conceptualization; Methodology; Data curation; Software; Validation; Formal analysis; Investigation; Writing original draft preparation; Visualization.
Ariful Hoque: Resources; Formal analysis; Review and editing; Supervision.
Thi Le: Review and editing; Supervision; Project administration.

Use of AI tools declaration

Grammarly was used to improve grammatical accuracy and clarity of expression in this article. All ideas, analyses, results, and conclusions are entirely the author's own.

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Conflict of interest

All authors declare no conflicts of interest in this paper.

Data Availability Statement

The data presented in this study are available on request from the corresponding author.

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