A Study on the Spillover Effects of International Green Bond Markets and Traditional Financial Markets

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Abstract: Based on the DY spillover index, this article investigates the interdependence between green bonds and financial markets in terms of time frequency . The empirical results indicate that there is a two-way volatility spillover between the markets and that the volatility spillover is exceptionally severe.The green bond market and bond market are net importers of volatility spillovers from equity and energy markets, especially in times of crisis. This paper provides new concepts for risk management and portfolio decisions-making for global green investors.

Keywords: green bonds; financial markets; DY spillover index

1 INTRODUCTION

According to reports from UNESCO since 2011, The world has realized that unlimited economic development and sustained growth may actually endanger the future of humanity. To achieve sustainable development, we must cooperate. Since the global financial crisis, a lot of writing has concentrated on analyzing the financial and economic relationships between various asset classes[1]. In actuality, investors pursue safe investments as a strategic objective to minimize shocks during uncertain financial times. People are therefore interested in researching the relationships and significant effects between various asset types, such as stocks, bonds, and commodities futures. and new markets for foreign exchange. Investigating the relationships between assets and cross markets is crucial because it highlights the significance of systemic risk. And provide insights on risk management and portfolio allocation for investors and portfolio managers. Provide insights into economic policy formulation to regulatory agencies.

Green bonds have become a new financial tool to address the challenge of reducing social and environmental risks. And investment portfolio.257 In 2019, global green bonds and green loans reached $700 millionThe United States, China, and France account for 44% of global circulation.In the past few years. The green bond market has aroused strong interest in sustainability as companies face pressure to reduce environmental impacts and increase. Influence InvestmentGreen bonds are often seen as social and ecological tools to meet the world's demand for sustainable green investment.Eller and Packaging Worker (2017) Green bonds are crucial for issuers and investors to meet the expectations of environmental project financing needs[2].

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The latest COVID-19 epidemic is classified as one of the serious infectious diseases that seriously affect global financial and economic outcomes[3].With the unexpected turbulence in the financial market, the economy is facing some serious challenges.Financial markets such as the US stock market have experienced significant declines in just a few weeks, and the pandemic has sparked growing fear and chain reaction. Relieve all market distortionsTraditional financial markets face risks of reduced economic activity, financial instability, increased uncertainty, and risk management.eThe COVID-19 is detrimental to the world's financial markets and economy[4].

During the abnormal state of global financial markets during the pandemic.It's important to consider how green bonds protect traditional assets.To encourage leverage, it is essential to make sense of the intricate connection between the traditional financial markets and the green bond market. Optimize global investment structure and improve global financial environment[5].

This study focuses on examining the interaction between the global green bond market and conventional financial markets in this environment. Especially in the context of the global crisis, it provides guidance for investors' portfolio selection.

2 Empircial methods

This article uses an improved overflow index model developed by Diebold and Irmaz in 2021, with a focus on measuring the size and dynamics of the overflow. fluctuation between traditional financial markets and the global market for green bonds.On the one hand, the DY model By using a general vector autoregressive pattern, the dependence on possible outcomes in variable delay sequences is reduced, and vice versa. Leakage volume between different markets in different directionsDY leakage index model After improvement, the empirical results were measured in two different ways, mainly using static leak index tables and dynamic leak index graphs. It shows the dynamics of the mechanisms that guide volatility between different markets.The main explanation of this method is as follows:

In order to analyse the variance of the prediction error based on the orthogonal impulse response，Denoting the KPPS H-step-ahead forecast error variance decompositions by $\theta_{ij}^{g}(H)$， for H=1,2,…,， we have：

$$\theta_{ij}^{g}(H)=\frac{\sigma_{ii}^{-1}\sum_{h-0}^{H-1}\left(e_i^{'}A_h\sum e_j\right)^2}{\sum_{h-0}^{H-1}\left(e_i^{'}A_h\sum A_h^{'}e_i\right)} \qquad (1)$$

The variance decomposition table's element sums for each row do not add up to 1: $\sum_{j=1}^{N}\theta_{ij}^{g}(H)\neq 1$.To calculate the spillover index using the information available in the variance decomposition matrix, we normalised each element of the variance decomposition matrix to the form of a row sum:

$$\tilde{\theta}_{ij}^{g}(H)=\frac{\theta_{ij}^{g}(H)}{\sum_{j=1}^{N}\theta_{ij}^{g}(H)} \quad (2)$$

Note that，by construction，$\sum_{j=1}^{N}\tilde{\theta}_{ij}^{g}(H)=1 and \sum_{i,j=1}^{N}\tilde{\theta}_{ij}^{g}(H)=N$。

The total spillover index, the directional spillover index, and the net spillover index can then be created.

1.Total spillover index. The overall volatility spillover index calculates how much the total forecast error variance for all other variables is affected by volatility spillover shocks:

$$TS(H)=\frac{\sum_{i,j=1,i\neq j}^{N}\tilde{\theta}_{ij}^{g}(H)}{\sum_{i,j=1}^{N}\tilde{\theta}_{ij}^{g}(H)}\times 100=\frac{\sum_{i,j=1,i\neq j}^{N}\tilde{\theta}_{ij}^{g}(H)}{N}\times 100 \quad (3)$$

2.Directional spillover indices. The generalized VAR model, DY Spillover Index Model (2012), measures the magnitude of directional spillovers between different markets, called directional spillover indices. The directional spillover index uses equations (4) and (5) to measure the magnitude of the spillover effect of market i on all other markets j, respectively, and the magnitude of the spillover effect of all other markets j received by market i, denoted as：

$$DS_{i\leftarrow j}(H)=\frac{\sum_{j=1,j\neq i}^{N}\tilde{\theta}_{ij}^{g}(H)}{\sum_{j=1}^{N}\tilde{\theta}_{ij}^{g}(H)}\times 100=\frac{\sum_{j=1,j\neq i}^{N}\tilde{\theta}_{ij}^{g}(H)}{N}\times 100 \quad (4)$$

$$DS_{i\rightarrow j}(H)=\frac{\sum_{j=1,j\neq i}^{N}\tilde{\theta}_{ji}^{g}(H)}{\sum_{j=1}^{N}\tilde{\theta}_{ji}^{g}(H)}*100=\frac{\sum_{j=1,j\neq i}^{N}\tilde{\theta}_{ji}^{g}(H)}{N}*100 \quad (5)$$

3. Net spillover index. The difference between the total shocks sent from other markets to market i less the total shocks conveyed from market i to other markets is used to calculate the net spillover from a single market to other markets, and is represented as follows:

$$NS_{i}(H)=DS_{i\rightarrow j}(H)-DS_{i\leftarrow j}(H) \quad (6)$$

4.Net pairing premium index. The volatility spillover impact between two separate markets is measured by the net pairing premium index. The difference between the total volatility shock sent from market i to market j and the total volatility shock transmitted from market j to market i is used to compute the net pairing premium between markets i and j:

$$NPSI_{ij}^{g}(H)=\left(\frac{\tilde{\theta}_{ji}^{g}(H)}{\sum_{i,k=1}^{N}\tilde{\theta}_{ik}^{g}(H)}-\frac{\tilde{\theta}_{ij}^{g}(H)}{\sum_{j,k=1}^{N}\tilde{\theta}_{jk}^{g}(H)}\right)\times 100=\left(\frac{\tilde{\theta}_{ji}^{g}(H)-\tilde{\theta}_{ij}^{g}(H)}{N}\right)\times 100 \tag{7}$$

3 Data and descriptive analysis

3.1 Data selection

In this study, we looked at how the booming green bond market affected other financial markets throughout the world. The corporate bond market, stock market, and energy market are all included in this.It's important to note that the financial products traded on these marketplaces are viewed as an addition to portfolios of green bonds.Global Green Bond Indexes, such as the Bank of America Merrill Lynch Green Bond Index (ML_GB), Standard & Poor's Dow Jones Green Bond Index (DJ_GB), Green Sol Active Bond Index (SOLAC), and Barclays Morgan Stanley Capital International Green Bond Index (MSCI_GB), are all examples of such indices.Because these exponential structures are similar, they exhibit a maximum correlation close to 1.Therefore, To examine the worldwide green bond market, we utilize the Bloomberg Barclays Green Bond Index.Bloomberg Barclays Global Enterprise IndexThis index includes global corporate bonds issued by the industrial, utility, and financial sectors of developed and developing countries.Similarly, the World Stock Price Index (WSPI) of Morgan Stanley Capital International (MSCI) is represented in the stock market.The world energy market is portrayed by the Morgan Stanley Capital International World Energy Price Index.Over 1400 stocks from 23 developed market nations are represented in the index.

The sample range for each of the four market indicators starts on January 2, 2015 and ends on April 28, 2023. These indicators will be converted into GARCH (1,1) and all empirical data in the next article are volatility.

Figure 1 shows the volatility of the four markets, and Table 1 shows descriptive statistical data on the volatility of the four markets.We will find that (1) Global green bond market volatility is comparable to that of the global bond market. The corporate bond market is slightly more volatile in both directions than the green bond market.(2) Global energy and stock markets have comparatively low levels of volatility.(3)In 2020, all four markets experienced significant fluctuations and jumps.

Table 1 Four asset types, log volatility summary information.

	Green.Bond	Aggregate	MSCI.Stock.	MSCI.Energy
Mean	-5.58	-5.84	-4.36	-4.91
Median	-5.67	-5.9	-4.38	-4.97
Maximum	-4.52	-4.68	-2.45	-2.72
Minimum	-6.21	-6.42	-5.24	-5.66
Std.Deviation	0.32	0.32	0.41	0.43
Skewness	1.04	0.72	1.05	1.03
Kurtosis	3.53	2.93	5.75	5.03

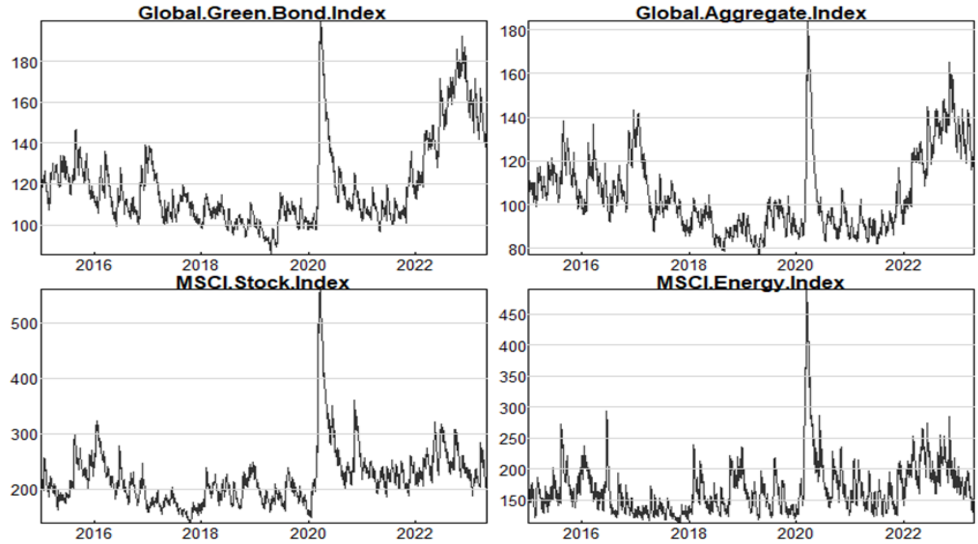

Fig.1. Daily financial market volatilities.

Table 2. Volatility spollover table,four asset classes.

	Green Bond	Aggregate Bond	MSCI Stock	MSCI Energy	FROM
Green Bond	51.73	38.31	1.2	8.76	48.27
Aggregate Bond	40.09	52.58	0.95	6.38	47.42
MSCI Stock	0.07	0.04	63.91	35.98	36.09
MSCI Energy	0.3	0.12	27.13	72.45	27.55
TO Others	40.46	38.48	29.28	51.12	TCI:(38.94/ 400):9.96%
Inlcuding Own	92.19	91.05	93.19	123.57	
NET	-7.81	-8.95	-6.81	23.57	

3.2 Effect of static fluctuation spillover

Analyze the effects of static volatility leakage between the four carbon markets and the market by constructing a static volatility leakage index table. The excessive volatility index for the international bond, stock, energy, and green bond markets is displayed in Table 2.

As shown in Table 2, the total market leakage index is the sum of the fluctuation leakage effects between two variables with a value of 9.96% indicates that the spillover effect of cross market fluctuations between the two markets is not strong. The directional net spillover index for each market is the total of the volatility spillover effects that each variable receives from the other variables, as seen in the green bond market, where it is the highest at 48.27, followed by the bond market at 47.42; it is also the total of the volatility spillover effects that each variable gives to the other variables, with the energy market having the lowest at l. This indicates the dominance of the green bond market in the overall system. The energy market is a spillover transmitter, while the green bond market, bond market, and equities market are all spillover recipients in terms of net volatility spillovers.

3.3 Effect of time-varying fluctuation spillover

3.3.1 total spillover effects

A static volatility spillover table alone cannot adequately capture the dynamic spillover effects that move over time, and with this in mind, this paper examines the time-varying spillover effects between the international green bond market and other markets using a rolling 200-day window, and Figure 2 shows the time-varying overall volatility spillover graph. We can see from Figure 2 that the overall volatility spillover index basically fluctuates between 30% and 50%. However, the spillover rises sharply to 70% in early 2020, fluctuates slightly between 65% and 70% throughout the year, and plummets to around 33% in early 2021. This phenomenon is attributed to the global epidemic of Neonic Pneumonia at the end of 2019, where the spillover index spiked during the initial period of the epidemic due to the transmission of risks between global financial markets, before the total spillover effect returned to normal values later on as various factors reduced the interaction between markets.

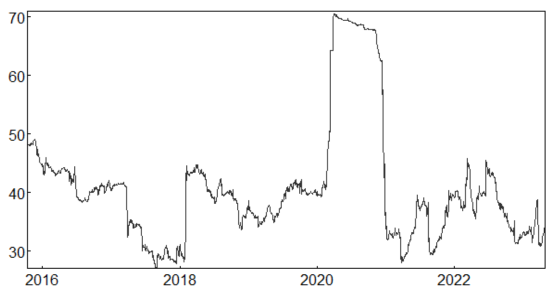

Fig.2. Total volatility spillovers.

3.3.2 directional spillover effects

The overall leakage index chart only measures the magnitude of the leakage impact of overall volatility between green bonds, corporate bonds, stocks, and the market. Workers unable to capture changes in directional and net leakage effects between the four marketsTherefore, this article further analyzes the impact of leaks on the time direction between markets, as well as the impact of net leaks.

In Figure 3, the time-varying directional volatility spillover from each of the four markets to the remaining markets is shown. For the green bond and bond markets, the spillovers are in the range of 10-15% during calm periods, but during turbulent periods, the directional spillovers fall below 5% for both bond markets. For the equity and energy markets, the spillover effect is below 15% in calm periods and increases sharply to over 30%, approaching 35%, in turbulent periods. So it can be said that of the four markets, the two bond markets are risk takers in times of crisis, while the equity and energy markets are risk transmitters in times of crisis.

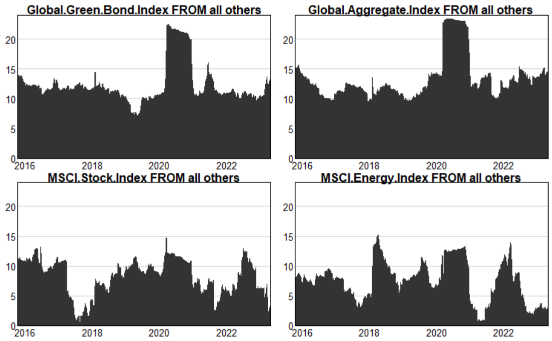

Fig.3. Directional volatility spillovers, TO four asset classes

In Figure 4, we show that each market is fluctuating and overflowing from other prats of the market. For the bond market and green bond market, during calm periods, the liquidity effect is less than 15%, but during volatility periods, the liquidity effect is less than 15%Due to directional overcurrent, it has increased by over 20%.For the stock and energy markets, during periods of calm, the overflow is less than 10%, while during periods of volatility, the overflow is less than 10% or nearly 15%.Among these four markets, the impact of energy spillovers in other markets is often smaller than in the other three markets.

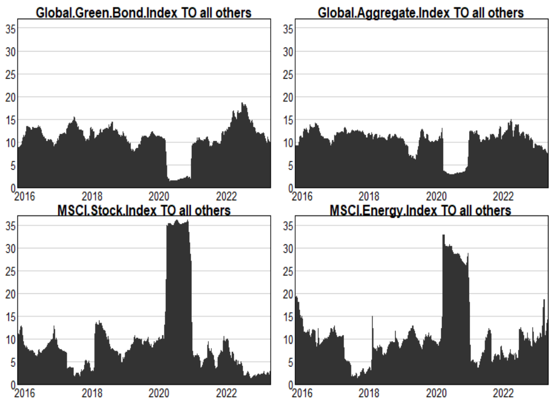

Fig.4 Directional volatility spillovers, FROM four asset classes.

3.3.3 net targeted spillover effects

Above, we briefly discussed the gross spillover diagram and we next focus on the time-varying net directional spillover diagram shown in Figure 5. We also calculate the net two-by-two spillover effect between the two markets and present it in Figure 6.

As shown in Figure 5, the net volatility between the two bond markets does not exceed 5%.Moreover, the net volatility between stock markets does not exceed 10%, and the non beginning of the year net volatility leakage rate between energy markets. In 2016, more than 10% of the market had positive and negative net spillover effects on the global COVID-19 epidemic.But in early 2020, the situation underwent significant changes, with a net overflow of approximately- 20%, the stock market exceeds 20%, and the energy market exceeds 15%.

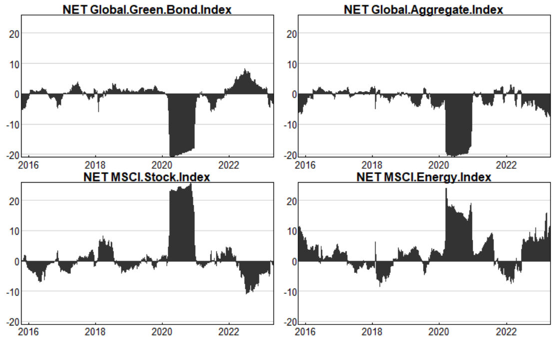

Fig.5. Net volatility spillovers, four asset classes.

Figure 6 plots the two-by-two net spillover index between the two markets and shows that the time-varying net spillover relationship between the markets does not always remain positive (the output of the volatility spillover from the green bond

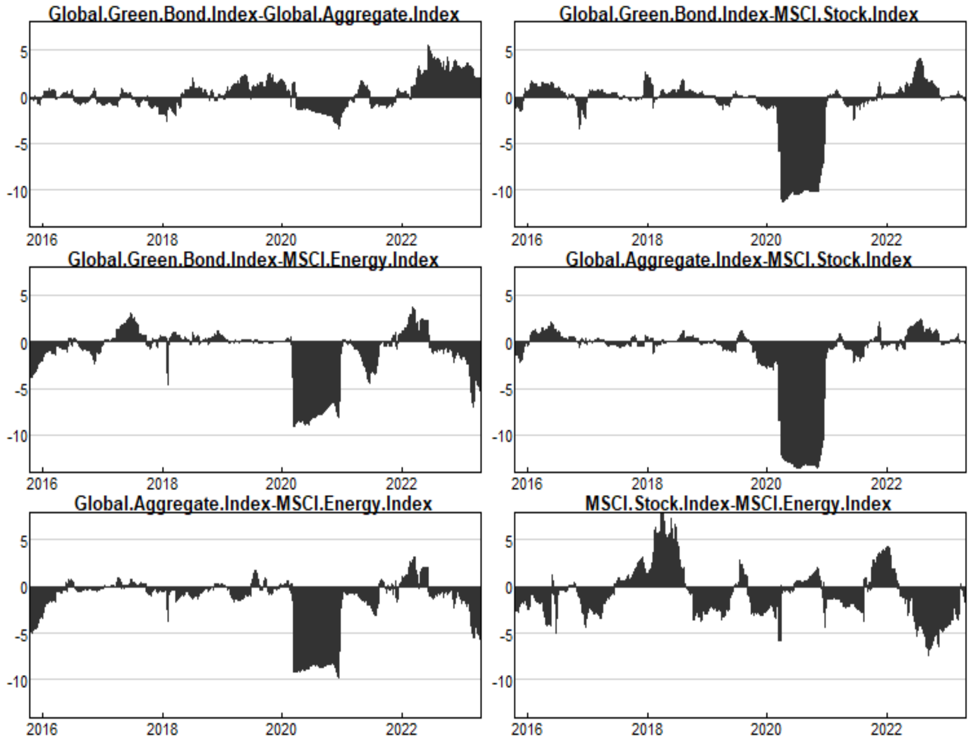

Fig.6 Net pairwise volatility spillovers

market to the energy market is greater than the input) or negative (the output of the volatility spillover from the green bond market to the energy market is less than the input), there is not just a unidirectional net spillover between the two markets, but a combination of two different directions of Net spillover.

In the case of the green bond market, net volatility will not affect the volatility of other markets.In fact, during the COVID-19 epidemic, the green bond and bond markets obtained considerable net spillover fluctuations from the stock market and the energy market. The bond market has also received overwhelming net volatility from the green bond market. Especially through the stock market rather than the energy market, net volatility is rampant. In times of crisis, the green bond market is a net recipient of the equity and energy markets, but indeed a net transmitter of the bond market.

4 Conclusions

This article is based on the DY leakage index model. Systematic quantitative analysis of the leakage impact between the international green bond market and traditional financial markets Exploring the Impact of International Green Bond Price Fluctuations on Traditional Financial MarketsIn short, there is a two-way fluctuation leakage between markets. But the nature of spillover effects and the relationship between net leaks between markets vary.In terms of spillover nature, the international green bond market is the most closely related.Net overflow relationship The green bond market and bond market were net importers of volatile stock and energy markets during the crisis. The green bond market is a net exporter of volatile bond markets.All leakage effects, directional leakage effects, and net leakage effects between markets show strong time differences.

Our empirical research findings have significant policy implications for diversification and management.The empirical result of the dynamic connection between green bonds and financial markets is Global Green Investors.

References

[1] Ahmed H. Elsayed(2022).Green Bonds and Financial Markets: Dependence Structure and Dynamic Connectivity: New Insights from Time-Frequency Analysis Before and During COVID-19 Pandemic, Energy Economics.Volume 107,105842.

[2] Juan C. Reboredo(2020). Andrea Ugolini,Price connectedness between green bond and financial markets,Economic Modelling,Volume 88,Pages 25-38.

[3] Linh Pham(2021).Frequency connectedness and cross-quantile dependence between green bond and green equity markets,Energy Economics,Volume 98,105257.

[4] Yang Gao(2021).Analysis of China's green bond and financial markets' risk spillover and network connectivity: Evidence from financial events between 2015 and 2020,The North American Journal of Economics and Finance,Volume 57,101386.

[5] Yonghong Jiang(2022).The relationship between green bonds and conventional financial markets: Evidence from quantile-on-quantile and quantile coherence approaches,Economic Modelling,Volume 116,106038.