Does compliance to Green Bond Principles matter? Global Evidence

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Abstract

We examine the effect of degree of compliance with the Green Bond Principles (GBP) on investor demand for such bonds, using cross-sectional data for all countries in the Green Bond market over the period 2007-2019. We find a significantly positive effect of higher compliance with the GBPs on investor demand, as measured by Bid-Ask-Spread and Yield-spread, after controlling for common bond-specific and macroeconomic variables. However, our results showed no evidence that macroeconomic factors influenced Green Bond investments. Moreover, we also find a positive effect on investor demand when a bond is issued by a government agency, even if the degree of compliance is low.[3]

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Keywords: Bond Market; Bid-ask spread; Green Bonds; Green Bond Principles; Compliance; Investor demand; Sustainability

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1. Introduction

Renewable energy technologies were identified as a 'Cinderella option' (Grubb, 1990), yet are now being identified as an urgent sector for global survivability. Green financing is the sole option that can be used to effectively finance renewable energy technologies (Gupta & Jham, 2021). However, it is evident that significant investment is required to achieve a low carbon economy with renewable energy technologies (Masini & Menichetti, 2012; Bobinaite & Tarvydas, 2014; Campiglio, 2016), and a huge gap exists between current and required green investment around the world, ranging from $650 to $900 billion (Campiglio, 2016).

It has been suggested that Green Bonds (GB) could meet this annual financing obligation for climate-resilient investments, and thus help reduce global warming (Bobinaite & Tarvydas, 2014). Further, the significance of GBs could expand rapidly with the establishment and standardisation of low-carbon technologies (The European Union, 2016). A GB is a debt instrument that aims to support environmentally friendly institutions and projects (Preclaw & Bakshi, 2015), especially projects labelled 'green'. Green projects are projects and activities that promote progress on environmentally sustainable activities, as defined by the issuer and in line with the issuer's project process for evaluation and selection (Darcy, et al. 2015; ICMA, 2018). GBs are viewed as a solution to financing less profitable, but essential, climate-resilient projects, and are designed with special features to attract investments. Institutional investors, who are interested to diversify their investment portfolio with ecological investments to demonstrate their environmental concern, are significantly active in the GB market. However, the low market attraction from the investor's side often hinders this market expansion (Wood & Grace, 2011). Over the years, financial experts have studied various aspects of GBs, yet have remained unsuccessful in providing solutions to the major problems associated with the future developments of the GB market. Since its inception in 2007, the participation of private companies—both as issuers and investors of GBs—has been relatively low (Inderst, et al., 2012). Investors expect a fair return to outweigh their risk on investment, and seek clarity and straightforwardness in their investments. This is lacking in the GB market. Investors who prefer to invest in environmentally resilient projects would use various methods to evaluate the project's greenness (Gupta & Jham, 2021). However, investors find it more costly and complex to evaluate the use of GB proceeds, the GB issuance process and the many different instruments to certify 'greenness' in the current market (Ehlers & Packer, 2016). As such, there is a huge gap between global GB investment requirements and current market investment. However, the recent trend in shifting the investors to Green Bond investments provide a green light on the increasing awareness of the people about the climate risk (Banga, 2019). This prompted us to identify the factors to be considered by investors before making investment decisions regarding GBs. This paper provides first empirical evidence that suggest the investor demand for GBs increases with the high degree of compliance with GBPs with a global coverage. The study uses cross-sectional data for all countries in the GB market over the period 2007-2019.

As advocated in the efficient market theory (1970), investors are rational when making investment decisions. Investors determine the risk-return trade-off of all possible investment options to reach an investment portfolio that best suits their level of risk aversion (Barber & Odean, 2013). However, prior studies have suggested that the behavior of investors is limited by their own intellectual bias and the exterior environment when not abiding by the assumption of rationality outlined in behavioural finance theory (Miller, 1977; Akerlof & Yellen, 1987; Barberis & Thaler, 2003; Wen, et al., 2014). Owing to both arguments, it is essential to identify the rational and the

behaviour of investors in the GB market. Therefore, this study focuses on examining investor behaviour in relation to the degree of compliance with the GBPs, which is an essential factor to mitigate the risk associated with GBs. We assume that investors in the GB market consider the degree of compliance—particularly the green certification—when making investment decisions. Our belief is consistent with the findings of Masini and Menichetti (2012), who examined the behavioural perspective of rational investors in the domain of renewable energy investments. Further, they revealed that the renewable energy share in the investment portfolio depends on the perceived importance of the type of policy scheme, level of support and level of confidence in market efficiency.

Our motivation is further prompted by the contradictory arguments over the issue of green certification by the Climate Bond Initiative (CBI), which is at present based on the level of compliance with GBPs. Whilst some studies highlight green certification as an important factor that influence investor decision making (Wood & Grace, 2011; Jun, et al., 2016; Ehlers & Packer, 2016; Maltais & Nykvist, 2020; Nanayakkara & Colombage, 2021), other studies doubt that green certification contributes towards creating green investments (The European Union, 2016). As a consequence of this contradiction, criticisms have arisen regarding obtaining green certificates. These criticisms relate to the re-labelling or repackaging of CBs; when repackaging does not bring additional eco-friendly benefits. Against this backdrop, our study departs in several aspects such as global coverage and methodology, and aims to bring empirical knowledge on the investor demand for GBs, which is a major gap in the current literature.

2. Literature review and development of the hypothesis

Although there is an urgent need for a transition to a sustainable economic structure through enviornmentally friendly projects, commonly known as green projects, the depressed macroeconomic system and unattractive risk/return profile of such investments act as a barrier for funding for these projects (Campiglio, 2016). Masini and Menichetti (2012) identify that, having strong policy frameworks and regulations at both local and international level leads to increase the allocation of funds by investors to green projects. The reduction of uncertainty allied with such projects, as a result of having strong policies to manage funds, is a key reason for the investor attraction. Therefore, an empirical investigation of the influence of degree of compliance with GBPs—the main international guideline available for issuers of GBs—on investor demand for GBs is timely and necessary.

Pattberg (2006) stresses the importance of having rules, regulations, and private schemes in global business regulations to influence the stakeholders to get rid of from the fear of greenwashing. He shows how the compliance on Coalition for Environmentally Responsible Economies principles positively affect the stakeholders' perspective on corporate environmental reporting and management and also how FSC forest management certification scheme affect to increase the area of forests in the world. These qualitative evidences prove the importance of being compliant with market related regulations and certifications to strengthen the confidence of stakeholders. However, the findings in the GB market in relation to the compliance with certifications are contradicted and inconclusive.

Menanteau, *et al*. (2003) and Luthi and Wustenhagen (2011) emphasize the importance of having principles, policies and supporting schemes for green projects to increase the share of such projects in the investment portfolio of green investors. IEA (2008b) highlights that it is vital to issue a green certificate to green projects owners in order to enhance the trustworthiness of the

projects and thereby to increase investor demand. This is essential since the high upfront cost associated with green projects is usually unbearable to project owners (Campiglio, 2016). These studies clearly explain the influence of principles and policies on investment demand for green projects. In particular to GBs, Wood and Grace (2011) state that the investors in GB market prefer to have clear standards or principles which govern GB issuance process. Jun, *et al* (2016) mention that it is necessary to stimulate the veracity of GBs through GBPs and Climate Bond Standards (CBS) to attract more investors to the GB market. Ehlers and Packer (2016) stress the importance of issuing a green certificate based on the compliance with GBPs by GB issuers to increase the investor demand for GBs. Moreover, Nanayakkara and Colombage (2021) show that being compliant with GBPs is a key factor that determines investor demand.

However, duPont, *et al*. (2015) and the European Union (2016) believe that the investors in the GB market do not consider the degree of compliance with GBPs or having a green certificate as significant factors in making investment decisions.

To assess investor demand in the bond market, previous studies have employed trading volume, represented by bond turnover ratio and BAS. Alexander, *et al*. (2000), Baker and Wurgler (2007) and Mizrach (2015) emphasize that trading volume reflects investors' sentiment of the market and thereby market liquidity. Moreover, Asia Bond Monitor (2015) claims that bonds turnover ratio is a measure of bond market liquidity, which subsequently reflects the investor demand for bonds. Amihud and Mendelson (1991) also identify the liquidity of capital assets as a base for investor decisions and portfolio composition.

Prior evidence on bond liquidity provides a few measures that replicate investor demand in the bond market, such as BAS; LOT estimate; percentage of zero returns; and YS for bond liquidity (Lesmond, et al., 1999; Collin-Dufrense, et al., 2001; Bekaert, et al., 2007; Chen, et al., 2007). Among these measures, BAS and YS are considered as better proxies for measuring bond market liquidity (Benston & Hagerman, 1974; Amihud & Mendelson, 1986; Hagerty, 1991; Crabbe & Turner, 1995; Gehrig & Jackson, 1998; Hong & Warga, 1998; Kempf & Uhrig-Homburg, 2000; Collin-Dufrense, et al., 2001; Longstaff, et al., 2005; Chen, et al., 2007). According to Amihud and Mendelson (1986) and Chen, *et al*. (2007), BAS is the most widely used and natural measure of illiquidity. Illiquidity is a function of the cost of immediate execution as the offer price consist of a premium for immediate purchasing and the bid price includes a concession for immediate sale. Hence, the spread between bid and ask price reflects the degree of willingness of the investor to buy a bond at the current bid or ask price (Amihud & Mendelson, 1986). Using more than 4,000 corporate bond (CB) issues over nine years, Chen, *et al*. (2007) conclude that liquidity is indisputably priced based on levels and changes in the YS. Similar findings were reported by Longstaff, *et al.* (2005) using 68 companies actively trading in the credit derivatives market in the US over five years. Past studies on the BAS and YS indicate a significant negative association with bond liquidity. Owing to these findings, our paper identifies high liquid (low spread) bonds as bonds with higher demand and low liquid (high spread) bonds as bonds with lower demand. Our identification is aligned with the findings in Nanayakkara and Colombage (2021). The above empirical findings lead to the formation of our main hypothesis:

H1: Higher the degree of compliance to principles, higher the demand for GBs.

In relation to the above hypothesis, we expect a negative association between high compliance bonds and the BAS.

3. Material and method

3.1 Data and variables

We use Bloomberg database to extract 2622 active GB issues as of December 2019 representing all types of issuers such as corporates including banks, governments representing municipals, local governments, and supranational. However, a number of GB issuances were excluded: (1) 455 supranational GB issues because of the unavailability of precise information on which countries finally benefited from them, and (2) 185 corporate and government GB issues due to the missing information that was required to run the model. These exclusions limit our sample to 1982 GB issues from 52 countries for the period 2007 to 2019. Table 1 depicts the summary statistics of the sample.

TABLE 1
Summary Statistics

	Mean	SD	Min	Max	Obs:
BAS (ratio)	.0076897	.0065668	.0000105	.0353535	1982
Yield spread (bps)	137.3183	131.0793	1.3449	770.2038	1982
High compliance	.3788235	.4856658	0	1	1982
Med. Compliance	.2352941	.4246824	0	1	1982
Low compliance	.3858824	.4873767	0	1	1982
Yield to maturity	3.41437	2.995128	7.649693	26.29922	1982
Mac duration	4.00903	3.313487	0	24.32397	1982
Issue size (Ln)	17.81287	2.846908	7.649693	26.29922	1982
Environment risk-H	.1905882	.3932279	0	1	1982
Environment risk-L	.8094118	.3932279	0	1	1982
Corporate issue	.8823529	.3225695	0	1	1982
Government issue	.1176471	.3225695	0	1	1982
Days (Ln)	7.670694	.6831132	2.3979	9.3768	1982
GDP per capita	10.52262	.7934127	7.471957	11.40554	1982
10-year Treasury rate	2.001971	1.532121	.01	9.96	1982

Following literature, we employed BAS and YS to proxy for investor demand. This is because these two measures are the only variables available at the time of bond issues. All other measurements identified in the literature are based on time series data.

Data on the BAS at the time of GB issue are collected from Bloomberg database. BAS is the difference between the price the investor is willing to pay and the price the issuer is willing to offer. We calculate the BAS ratio as follows.

$$BAS = \frac{Ask\ price - Bid\ price}{Ask\ price} \quad (1)$$

Based on the rationale that illiquid bonds trade less frequently and exhibit higher YS (Chen, et al., 2007), we employ a model with YS to preserve the robustness of our findings.[4] Bloomberg measures YS in terms of basis points (bps) and defines as the basis point yield spread over the benchmark (hedge) bond.

The independent variable of our study is the degree of compliance with GBPs, and is categorical in nature. As the secretary to the GBPs, International Capital Market Association (ICMA) is responsible for issuing and revising the principles according to the changing market needs. The GBPs act as a voluntary guideline to enhance the credibility of the issue to investors

[4] This rationale is based on the notion that a liquidity premium for illiquid securities demand by the investors by lowering security prices as they cannot hedge their risk continuously (Amihud & Mendelson, 1986; Lo, et al., 2004)

and promote market integrity. These principles provide guidelines for the issuers on the approach and supervision of the major components involved in the issue. They also assist investors by providing information to evaluate the environmental impact of their investment. The ICMA has issued four principles in relation to (i) the use of proceeds, (ii) the management of proceeds, (iii) the process for project evaluation and selection and (iv) reporting (International Capital Market Association, 2018).[5] Data on compliance with GBPs were mainly extracted from three sources of (i) Climate Bond Initiative's Green Bond database (ii) second party opinion reports at the time of issue and (iii) issuers' reports. In the current study, we have categorized the degree of compliance into three levels of: (i) high compliance if the issue follows all four GBPs, (ii) medium compliance if the issue complies with three GBPs and (iii) low compliance if the issue follows fewer than three GBPs. We used two dichotomous variables namely; (1) low compliance bonds and (2) medium compliance bonds in the model to capture low and medium compliance with GBPs respectively.

In order to control the effect of other factors in addition to our main independent variable, we employed few variables to capture the effects of bond yield, risk, issue size, maturity and macroeconomic factors.

Wang, *et al.* (2015) consider the yield to maturity (YTM) as a determinant of investor demand for bonds. Further, Amihud and Mendelson (1986) and Kempf and Uhrig-Homburg (2000) highlight that the asset return is a function of liquidity and has a positive association between liquidity measured by BAS and YTM. Validating these results Jacob and Robert (1991), Yakov and Haim (1991), Arthur (1992) and Avrabam (1994), document that with bond illiquidity the average return of asset increases.

Owing to the efficient market theory, our study captures the impact of security risk in terms of default risk, environment related credit risk and price volatility. According to Favero, *et al*. (2010), default risk decreses demand for liquidity and the premium on high liquid securities. They use bond issues in the euro zone at different maturities to test this notion while using BAS to capture the liquidity of bonds and YS as the proxy for default risk. They document a positive association between BAS and YS. Longstaff, *et al.* (2005), Ericsson and Renault (2006) and Chen, *et al.* (2007) report similar relationship between the variables. Kempf and Uhrig-Homburg (2000) emphasize the fact that the bonds issued by the government sector is generally default risk free and a better variable to separate the impact of liquidity from the impact of default risk. Owing to these arguments, we consider the issuer type (corporate or government) as a categorical variable which captures the default risk. This grounds us to be certain of those bonds issues by government agencies lead higher investor demand.

Price volatility is also considered a better indicator of market risk. Higher price volatility decreases the security turnover (Domowitz, et al., 2001). The duration can be identified as the primary measure of exposure to market risk and as a proxy for price volatility as it measures the sensitivity of bond or portfolio to its yield (Reilly & Sidhu, 1980; Dunetz & Mahoney, 1988; Kritzman, 1992). When price volatility is considered as price risk, duration can be considered as an index of risk for a given change in interests (Bierwag, et al., 1983). Shulman, *et al.* (1993) document a positive association between BAS and price volatility whereas Schwert (2017) report a positive association between liquidity measures and bond duration. These findings lead us to control for price volatility and we employ the Macaulay duration as the proxy for price volatility. We use information in Bloomberg database to obtain data for Macaulay duration.

[5] For more information, see Voluntary process Guidelines for issuing Green bonds (2018) by International Capital Market Association

Additionally, the study employed *Environment-related credit risk (ECR)* as a categorical variable, and quantified the variable using Moody's classification of credit exposure to environmental risk (immediate elevated, emerging elevated, emerging moderate and low) as the measurement criteria. If the bond issuer belonged to an industry that fell under immediate elevated, emerging elevated or emerging moderate risk, it was identified as a high environmental risk issue. If the bond issuer belonged to an industry that fell under low risk, it was identified as a low environmental risk issue. The particular industry to which the bond issuer belonged was identified through the Bloomberg database.

Number of bond market literature test the impact of size of issue on investor demand through BAS (Crabbe & Turner, 1995; Kempf & Uhrig-Homburg, 2000; Schwert, 2017). All these studies conclude with a negative association between liquidity spread and issue size. These findings motivate us to capture the effect of issue size on investor demand. We use Bloomberg database to obtain data for issue size.

The CB market literature emphasise that longer maturities increase the YS of investment-grade bonds (Campbell & Taksler, 2003; Chen, et al., 2007). GBs are generally issued with long time horizons (Campiglio, 2016) and rated as investment-grade securities by most rating institutions (Ehlers & Packer, 2017; VanEck, 2017). Owing to these facts in past studies, we include the GB maturity also as a control variable.

Empirical studies further point out the importance of considering the effect of macroeconomic variables in cross country bond market research (Collin-Dufrense, et al., 2001; Cavallo & Valenzeula, 2007). It is agreed upon, globally, that there is a close association between economic growth and investment/capital formation (Anwer & Sampath, 1999). According to Min (1998), a healthy macroeconomic situation causes high liquidity of bonds, whereas unhealthy macroeconomic indicators result in bond illiquidity. Schwert (2017) argued that the economic condition of a country is a significant determinant of borrowing cost. Cavallo and Valenzeula (2007) recognise GDP per capita as a better proxy for economic healthiness, whereas Collin-Dufrense, *et al*. (2001), Campbell and Taksler, (2003), and Chen, *et al*. (2007) identify treasury rate as a good indicator of the economic condition of a country. They proposed that the high treasury rate of an economy reflects lower risk for investments. Therefore, we employ GDP per capita and 10-year Treasury bond rate to capture macroeconomic effect. We extract macroeconomic data from multiple sources such as IMF, the World Bank, OECD and RBA databases.

3.2 Econometric identification

Our empirical analysis initially evaluated the effect of the degree of compliance with the BAS and subsequently with the YS. To this end, we consider the following specification as our main model. This model is aligned with the model proposed by Nanayakkara and Colombage (2021).

$$BAS_i = \propto + \sum_{j=1}^{2} \beta_{j,i} COMP_{j,i} + \sum_{j=1}^{4} \beta_{j+2,i} RS_{j,i} + \sum_{j=1}^{2} \beta_{j+6,c} MC_{j,c} + \beta_{9,i} YTM_{j,i} + \beta_{10,i} lnSIZE_{j,i} + \beta_{11,i} DAYS_{j,i} + \varepsilon_i \quad (2)$$

where *BAS* is the BAS of bond *i*, the vector of the *COMP* variable contains the independent variables used to capture the degree of compliance with the GBPs of bond *i* with a vector of $\beta_{1\text{-}2}$ coefficients, the vector of *RS* variables contains the four control variables used to capture the effect of bond risk with a vector of $\beta_{3\text{-}6}$ coefficients, and the vector of *MC* variables contains the two

control variables used to capture the macroeconomic variables with a vector of $\beta_{7\text{-}9}$ coefficients. *YTM* is the YTM of bond *i*, *lnSIZE* is the natural logarithm of the size of issue of bond *i*, *DAYS* is the days to maturity and ϵ is the error term.

Before estimating the test results, we identify the outliers, leverage and influential data using a scatterplot matrix, individual scatterplot diagrams and stem-and-leaf plot. We drop the identified plots of major concern after including and excluding them when estimating our model (Chen , et al., 2003). We check for normality of residuals using kernel density estimate, standardized normal probability test and quantiles of the normal distribution. We also plot the standardized residuals against each of the predictor variables in the model to see whether any nonlinear pattern exists (Hamilton, 2013). The test results satisfy the linearity assumption. Then we test for heteroscedasticity using Breusch-Pagan test and used robust standard errors to correct the heteroscedasticity.

We also examine our variables for multicollinearity using VIF test and results confirm that there is no multicollinearity issue in our model.

4. Results

4.1 Effect of Green Bond Principles on Investor demand

We first conduct our cross-sectional analysis to examine the impact of degree of compliance with GBPs on investor demand for such bonds. Table 2 reports three variants of equation (2) for our first regression analysis.

TABLE 2
Bid-ask spread and Green Bond Principles

	(01)	(02)	(03)
Bid-ask spread (bps)			
Low compliance	29.671***	29,154***	28.274***
	(5.49)	(5.51)	(5.34)
Medium compliance	15.784**	16.389***	16.774***
	(2.46)	(2.52)	(2.58)
YTM	4.878***	4.824***	4.679***
	(4.39)	(4.46)	(4.31)
Yield spread	0.148***	0.147***	0.145***
	(5.24)	(5.14)	(5.14)
Macaulay duration	4.626***	4.785***	4.846***
	(5.48)	(5.84)	(5.98)
Issue by government	-12.163**	-12.84***	-13.367***
	(-2.44)	(-2.66)	(-2.85)
Environment related credit risk – low	1.741		
	(0.27)		
Issue size (ln)	-3.944***	-3.894***	-3.791***
	(-3.23)	(-3.16)	(-3.06)
Days (ln)	2.922		
	(0.80)		
10-year treasury bond rate	-3.82*	-2.499*	
	(-1.67)	(-1.80)	
GDP per capita	-3.325		
	(-0.71)		
Constant	95.652*	80.772***	74.757***
	(1.66)	(3.36)	(3.10)
R^2	0.5168	0.5154	0.5121
Observations	1982	1982	1982

The table reports coefficients and t-statistics (in parentheses) from the first estimation and re-estimations of equation (2) respectively. The dependent variable in all regressions is the Bid-ask spread of the bond issue i. All regressions are estimated with cross-sectional regression analysis and robust standard errors (adjusted with White robust estimate technique). *, **, *** marks denote statistical significance at the 10%, 5% and 1% level respectively. Variables significant at 10% level do not consider in the final estimation. Overall F –stats are 66.27, 85.33 and 94.12 respectively with p-value 0.0000.

Our preliminary regression results with White robust variance estimates show that a bond issue with low or medium compliance with GBP increases the BAS than the high compliance issues. Not surprisingly, our control variables; YTM, YS, Macaulay duration, issue size and issuer type also showed significant associations with the anticipated signs.

In contrast, the results indicate a statistically insignificant relationship between BAS and GDP per capita, days to maturity and ECR. The Wald test was used to determine the joint significant of these three variables and identified that they were insignificant jointly (F-stat's p-value = 0.5681). Estimated outcomes of 10-year treasury rate were unable to provide a significant result at least at 5% significant level.

Our results reflect that, investors preferred to invest in high compliance bonds compared to the low and medium compliance bonds irrespective of the type of the issuer. As per the refined results, a bond issue with low compliance to GBP increases the BAS by 28.27bps than a high compliance issues, whereas a medium compliance increases BAS by 16.77bps than a high compliance issue. The magnitude of the coefficient describes that a 1% increase of YTM increases BAS by 4.68bps. Also, 1bps increase of YS leads to increase BAS by 0.145bps and 1 period increase of Macaulay duration results in an increase of BAS by 4.84bps. Further, BAS decreases by 13.36bps if the bond is issued by a government institution rather than a corporate issue. A 100% increase in issue size reduces BAS by 3.79bps.

Nevertheless, all estimations in Table 2 provide evidence for a statistically significant association between investor demand reflected by BAS and degree of compliance with GBP to support the main notion of this study.

The literature has identified that strong policy frameworks increase the renewable energy share in the investment portfolio (Menanteau, et al., 2003; Luthi & Wustenhagen, 2011; Nanayakkara & Colombage, 2021), which was confirmed by this study in relation to GB investments. In contrast to the findings of duPont, *et al.* (2015) and the European Union (2016), this study provides empirical evidence that the degree of compliance with the GBPs is an essential factor considered by investors in the GB market.

Most of the results for the control variables are consistent with the evidence from CB market literature. The findings on YTM support the 'trading cost view' in the literature by showing a statistically significant positive relationship with liquidity spread. The trading cost view suggests that the high trading cost of illiquid assets compensates the investor with a high average return on assets, particularly bonds, and shows a positive relationship between returns and illiquidity. Amihud and Mendelson (1986) suggest that the asset's return is high for illiquid securities, while Boudoukh and Whitelaw (1991) confirm that the YTM of high liquid bonds is lower than that of low liquid bonds. Amihud and Mendelson (1991) find a positive association between BAS and YTM. A subsequent study by Warga (1992) also confirm this relationship. Similar to these conclusions in the CB literature, the outcome of this analysis confirms that investors in the GB market also consider the return on investment prior to making their decision.

In addition to the above 'trading cost view', the 'liquidity risk view' also prices liquidity (Pastor & Stambaugh, 2003; Favero, et al., 2010). The premium on highly liquid assets declines at a time of high-risk expectation. In contrast, the aggregate high risk increases illiquidity of assets

(Favero, et al., 2010). According to Vayanos (2004), demand for liquidity rises with high risk, yet does not respond to trading cost. These studies mainly employed the YS to capture the default risk and BAS to capture the liquidity of security. While employing YS to capture the default risk and BAS to capture the liquidity of a security, the CB literature advocates a positive association between liquidity spread and default risk (Longstaff, et al., 2005; Ericsson & Renault, 2006; Chen, et al., 2007; Favero, et al., 2010).

Min (1998) stresses a positive influence of CB issues on the YS, which is consistent with the model for robustness in this study. He argues that the corporate issuers are likely to have a higher spread than public issuers. Kempf and Uhrig-Homburg (2000) who used BAS to measure the liquidity, point out that the government bonds are default-risk free. We do not come across studies that have used the Macaulay duration, which measures the price volatility of bonds.[6] However, previous studies which used alternative proxies for price volatility suggest a positive influence on bond spreads (Shulman, et al., 1993; Schwert, 2017).

Multiple studies claim that the larger issues trade more frequently (Fisher , 1959; Houweling, et al., 2005; Schwert, 2017). Schwert (2017) finds a negative association between amount issued and the liquidity spread although the effect is not statistically significant. Similary, Kempf and Uhrig-Homburg (2000) and Crabbe and Turner (1995) also find an insignificant inverse association. Interestingly, in the context of the GB market, our results confirm statistically significant inverse association between the size of issue and bond spreads.

We find consistent results with Schwert (2017) for GDP per capita showing a negative insignificant relationship with liquidity spread. The liquidity spreads are not exposed to economic conditions of different geographical locations (Schwert, 2017). He further reports some insignificant macroeconomic variables such as GDP growth rate and treasury bill rate. In consistent with Chen, *et al*., (2007), we also find a negative but insignificant association between BAS and treasury rate. Contrary to this relationship, Min (1998) finds an insignificant positive relationship between treasury bill rate and the YS.

As model specification errors considerably affect the approximation of regression coefficient (Chen , et al., 2003; Hamilton, 2013), we conducted both link test and Ramsey RESET test for the model with the null hypothesis of the model has no omitted variables. Both test results failed to reject the assumption that the model is specified correctly (F stat's p-value of Ramsey RESET test using powers of the fitted values of BAS is 0.1552 whereas t stat's p-value for the variable of squared prediction of link test is 0.252).

4.3. Low compliance GB issued by government agencies

Our main effect model as in equation (2) suggests that the government bond issues increase the investor demand for GBs. Hence, it is worthwhile to check whether government bond issues offset the impact of degree of compliance to GBP for investor demand. We assume that there is an inverse association between BAS and low compliance when the bond is issued by a government agency. To test this premise, we introduce a double interaction term between government issues and low compliance bonds and build equation (3).

$$BAS_i = \propto + \sum_{j=1}^{2} \beta_{j,i} COMP_{j,i} + \sum_{j=1}^{3} \beta_{j+2,i} RS_{j,i} + \beta_{6,i} LCOMP \times GOV_{j,i} + \beta_{7,i} YTM_{j,i} + \beta_{8,i} lnSIZE_{j,i} + \varepsilon_i \quad (3)$$

[6] We do not use price volatility of security since we gather data at the time of bond issue.

Where *LCOMP* × *GOV* captures the interaction effect between low compliance and government issues

Our results reveal that the interactive term is statistically significant with the anticipated sign. Further, estimated results for other control variables are consistent with those reported in Table 2. Column (1) in Table 3 presents the results for equation (3) with corresponding t-values after correcting for heteroscedasticity. We also include the refined results of equation (2) for comparison purposes in column (2) of the same table.

TABLE 3
Bid-ask spread and low compliance bonds issue by government agencies

	(01)	(02)
Bid-ask spread (bps)		
Low compliance	33.168***	28.274***
	(5.71)	(5.34)
Medium compliance	17.155***	16.774***
	(2.64)	(2.58)
YTM	4.555***	4.679***
	(4.21)	(4.31)
Yield spread	0.143***	0.145***
	(5.11)	(5.14)
Macaulay duration	4.848***	4.846***
	(6.04)	(5.98)
Issue by government	-0.434	-13.367***
	(-0.09)	(-2.85)
Issue size (ln)	-3.693***	-3.791***
	(-3.00)	(-3.06)
Low compliance* government issue	-39.101***	
	(-5.83)	
Constant	71.76***	74.757***
	(2.99)	(3.10)
R^2	0.5211	0.5121
Observations	1982	1982

The table reports coefficients and t-statistics (in parentheses) from the estimations of equation (3) and (2) respectively. The dependent variable in both regressions is the Bid-ask spread of the bond issue i. All regressions are estimated with cross-sectional regression analysis and robust standard errors (adjusted with White robust estimate technique). ** and *** indicate the statistical significance at 5% and 1% levels respectively. Overall F –stats for Eq. (3) and (2) are 108.58 and 94.12 respectively with p-value 0.0000.

The results indicate that a government bond issue causes a decrease in the spread by 33.16bps, compared to a corporate issue, even though the corresponding bond issue has low compliance. This finding strengthens our argument that the government GB issues are able to buffer the adverse effect of being non-compliant with the GBPs. This can be explained by the high credibility and less default risk of government bonds, compared to CB issues.

4.4. Robustness

This section presents the robustness of the findings in the previous section. We used the YS as an alternative proxy to reflect investor interest to observe whether the results are sensitive to methodological and estimation issues. All other variables and the sample remain the same.

$$YS_i = \propto + \sum_{j=1}^{2} \beta_{j,i} COMP_{j,i} + \sum_{j=1}^{3} \beta_{j+2,i} RS_{j,i} + \sum_{j=1}^{2} \beta_{j+5,c} MC_{j,c} + \beta_{8,i} YTM_{j,i} + \beta_{9,i} lnSIZE_{j,i} + \beta_{10,i} DAYS_{j,i} + \varepsilon_i \quad (4)$$

The three risk variables used in this equation were as follows: type of issuer dummy, ECR dummy and Macaulay duration.

The results were consistent with the findings of our main model, with BAS as the dependent variable showing that high compliance creates high investor demand for GBs. Consistently, YTM, Macaulay duration, issue size, and government bond issues showed statistically significant results and expected signs with slightly changing magnitudes of coefficients. As shown in Table 4, GDP per capita, 10 years Treasury bond rate, ECR and maturity become insignificant, but with anticipated signs, except for GDP per capita. GDP per capita shows a positive association with statistically significant results at 10% significance level, as shown in column (1) of Table 4, yet became insignificant when re-estimating the equation by dropping the other insignificant variables.

TABLE 4
Yield spread and Green Bond Principles

Yield spread (bps)	(01)	(02)	(03)
Low compliance	35.52868***	40.02789***	41.0441***
	(2.64)	(3.49)	(3.59)
Medium compliance	27.67414*	26.20365*	26.46211*
	(1.80)	(1.73)	(1.76)
YTM	16.40914***	16.70081***	16.6433***
	(5.66)	(5.81)	(5.82)
Macaulay duration	8.943381***	9.168948***	9.173644***
	(4.22)	(4.76)	(4.78)
Issue by government	-50.31759***	-50.4844***	-50.08722***
	(-5.24)	(-5.62)	(-5.60)
Environment related credit risk – low	-20.36609		
	(-1.09)		
Issue size (ln)	-5.607465***	-5.366912***	-5.277799***
	(-2.83)	(-2.64)	(-2.62)
Days (ln)	3.152756		
	(0.38)		
10-year treasury bond rate	9.719122		
	(1.40)		
GDP per capita	19.13751*	3.976547	
	(1.69)	0.62	
Constant	-97.9207	81.14616***	121.1468***
	(-0.74)	(1.09)	(3.16)
R^2	0.3492	0.3394	0.3389
Observations	1982	1982	1982

The table reports coefficients and t-statistics (in parentheses) from the estimations of equation (5). The dependent variable in all regressions is the Yield spread of the bond issue i. All regressions are estimated with cross-sectional regression analysis and robust standard errors (adjusted with White robust estimate technique). *, **, *** marks denote statistical significance at the 10%, 5% and 1% level respectively. Overall F –stats are 20.74, 26.94 and 35.19 respectively with p-value 0.0000.

Our regression results in column (3) with White robust variance estimates show that a low compliance bond issue increases the YS by 41.04bps, compared with a high compliance issue, while a medium compliance issue increases the spread by 26.46bps than a high compliance issue. Hence, these results validate the findings based on our main model and unveil that low and medium compliance significantly reduces investor demand for GBs. As per our results, YS increased by 16.64bps with respect to a 1% increase of YTM, and by 9.17bps with respect to a one-period increase of Macaulay duration. YS decreased by 50.08bps if a bond was issued by a government

agency, compared with a corporate issue, and decreased by 5.27bps for a 100% increase in issue size.

Finally, we ran the Link test, and was satisfied with the model specification, with a p-value of 0.000 for _hat t-statistic and a 0.692 p-value for _hatsq t-statistic. In summary, this analysis demonstrate that the results remain robust to an alternative measure of investor demand.

5. Conclusion

Although there is a high need to finance environmentally friendly projects, only a limited number of studies have been conducted to investigate the lack of investor interest in this market. To fill this void, we analyse a large sample of global data to examine the effect of degree of compliance with GBPs on investor demand. We find that the degree of compliance has a significant positive effect on investor demand. We used the liquidity measures of BAS and YS as proxies for investor demand. We find that high compliance with GBPs increases market demand for GBs.

Extending our study, we also reveal that bonds issued by government agencies are able to partially compensate the effects of low investor interest because of non-compliance with the GBPs. However, we were unable to establish a statistically significant relationship between investor demand and the macroeconomic variables. This result is consistent with previous researchers who were unable to explain the non-statistical outcome for the relationship between macroeconomic variables and market liquidity. Although we find a positive relationship between maturity and investor demand, surprisingly, the association was statistically insignificant.

This paper contributes to the lacking literature on GB market with implications for scaling up the global GB market. Our findings encourage policy makers to make voluntary principles mandatory to assess, monitor, verify and report the use of funds throughout the GB's maturity. Mandatory compliance will help prevent misuse of funds raised by issuing GBs for activities other than climate resilient projects. The global market can be scaled up by creating a markets credibility and trustworthiness among investors. This can be achieved by issuing a compliance certificate through authorized institutions, such as CBI, the ICMA or a government organization in each country, and requiring the holding of a certificate to be compulsory when issuing GBs in the capital market. [7] Our findings encourage governments to intervene in the GB market by enhancing the market's regulations to increase its trustworthiness. The outcome of this study suggests that more opportunities are available for government institutions to finance environmentally friendly projects by issuing GBs due to investors' perception of default risk associated with government bonds. Therefore, local governments and municipals can take this opportunity to issue GBs with more attributes.

In summary, issuers' compliance to GBPs will increase investor demand which results in adequate funding for environmentally friendly projects.

[7] The certificate issue by CBI is not compulsorily to obtain whereas the People's Bank of China's certificate is not internationally accepted even it is mandatory in China.

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