ORIGINAL ARTICLE

Stock market reaction to green bond issuance

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Abstract

This study examines the stock market reaction to the announcement of green bond issuance. The cumulative abnormal returns are positive and significant. This implies that shareholders view this form of financing as value-enhancing and funds from green bonds issuance are used to undertake profitable green projects or as a means of risk mitigation. Regression analysis shows that green bonds with higher coupon rates elicit a negative investor reaction. Also, firm size, Tobin's Q, and growth are positively related to the CAR, while operating cash flow is negatively related to the CAR. The positive coefficient for firm growth is consistent with the value-enhancing function of funds from green bonds.

Keywords Green bonds · Event study · Environmental sustainability

JEL Classification G1 · M14 · Q5

Introduction

Environmental sustainability is becoming either a driver of new business opportunities or a key consideration in mitigating economic and reputational risk as well as regulatory and litigation risk. In addition, environmental impact and sustainability of projects are becoming an important aspect of the portfolio investment decisions by institutional investors such as pension fund. Given the recent introduction and growth of green bonds, an examination of the market reaction is warranted. Green bonds not only provide a means to achieve risk mitigation, but also an opportunity to undertake new value-enhancing projects while limiting their impact on the environment. For example, Toyota is utilizing its green bonds to finance car loans for electric and hybrid car purchases. Funds from green bonds issuance can allow a firm to cut costs and increase efficiency while reducing its impact on the environment.[1] Hence, its issuance should have an impact on shareholder wealth and firm value.

Alternatively, investors may view green bonds issuance as simply firms' attempt to obtain capital from investors with environmental, social, and governance (ESG) mandates. For example, 60% of Electricite de France's (EDF), 2013 green bonds went to investors with ESG criteria. Among these investors, wealth maximization is not the leading decision criteria for investments in firms. Hence, we expect a neutral or negative impact if green bond issuers are simply trying to utilize a new source of funding. In this case, the market reaction to funds raised via green bonds can be interpreted as not driving environmental sustainability through new business opportunities or mitigating economic and reputational risk.

The green "labeled" bond market is fairly new and developing rapidly. Even though the market is growing, it is still in its infancy and it is less than 1% of the total global bond market. As the securities market develops, regulations and policies tend to take shape. Given that regulations and policies are being developed, this is not only timely, but the potential findings are important in shaping regulations and polices that will govern this segment of the capital market.

Green bonds are similar, conceptually, to standard fixed income securities.[2] The difference is how the proceeds from the issuance are utilized. Proceeds from green bond offerings are applied solely toward funding green projects. The

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[1] Apple's $1.5bn green bond, announced February 16, 2016, will fund several initiatives, including the company's conversion to 100% renewable energy, installation of more energy-efficient heating and cooling systems and an increase in the company's use of biodegradable materials.

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[2] These are self-labeled as green bonds. There are other fixed income instruments issued to fund environmentally friendly projects such as wind or solar farms, but these are not examined in this study.

challenge is the definition of a green project.[3] Typically, issuers will outline what projects are considered green projects. In the majority of cases, issuers will seek a second review of suitability of the green bond framework from an independent third party, such as Centre for International Climate Environment Research (CICERO). Ultimately, green bonds are a means to fund environmentally sustainable projects using private funds and the capital markets.

Green bonds were primarily utilized by supranational agencies, and federal, local, and municipal governments to fund projects that are considered to be environmentally friendly. However, corporations such as Toyota, Bank of America, and Unilever have used this market to raise funds. These funds are to be used to finance environmentally sustainable projects. Therefore, an examination of whether the stock market views this form of financing as important in mitigating economic or reputational risk or drivers of new business opportunities is needed.

The objective of this paper is to examine whether issuing "self-labeled" green bonds creates value for shareholders by analyzing stock market reaction to the announcement of green bond issuance. In addition, using regression analysis, the paper aims at identifying both bond and firm characteristics that explain the market reaction to green bond issuance. The event study findings indicate that green bonds issuance results in an increase in shareholder value. The cumulative abnormal returns over a 21-day window (CAR − 10, + 10) are positive and significant. In addition, regression analysis reveals that several bond and firm characteristics can explain the cumulative abnormal returns. For example, investor reaction to green bonds with higher coupon rate is weaker compared to those with lower coupon rate. In terms of firm characteristics, size, Tobin's Q, and asset growth are positive and significant in explaining the CAR, while operating cash flow is negatively related to the cumulative abnormal returns.[4] The findings for asset growth is consistent with the argument that green bond funding will be utilized for value-enhancing projects that minimize the impact on the environment.

This is the first paper to examine the shareholder wealth effects of green bond issuance by publicly traded corporations. The paper contributes to the existing bond market literature by examining this unique and emerging aspect of the bond market. Even though the green bond market is relatively small compared to the rest of the corporate bond market, it is nevertheless an important aspect of the market in light of the ongoing debate with regard to environmental sustainability and climate change. This paper also contributes to the corporate social responsibility literature as well as the impact investing literature. The findings are applicable to investors with environment, social, and governance (ESG) investment mandates, and decision-making criteria.

The remainder of the paper is structured as follows: "Brief history of the green bond market and the related literature" Section contains a brief history of the green bond market. The data, methodology, and summary statistics are outlined in "Data, methodology, and descriptive statistics" Section, and the results are reported in "Results" Section. "Conclusions" Section concludes the paper.

Brief history of the green bond market and the related literature

Brief history of the green bond market

The green bond market grew from $0.8b in 2007 to $81 billion in 2016 (Climate Bond Initiative). However, this market is still in its infancy and is less than 1% of the total bond market. Figure 1 shows the recent growth in this market. The figure shows accelerated growth in this segment of the bond market in recent years from just over $10b in 2013 to $81b in 2016. This is a 710% growth in the market. In 2016, Chinese firms accounted for 27% ($23b) of total green bonds issued.

In addition, Fig. 2 presents the breakdown of the use of proceeds for 2016 for all green bonds issued during that year. Energy-related projects account for over 38% of all funds raised. Investment in low carbon transport (16%) and sustainable water (14%) accounted for 30% of green bonds issued. Energy-efficient buildings accounted for 18%, while the remaining proceeds from the 2016 green bond market were allocated to investments in waste management (6%), agriculture and forestry (2%), and climate adaptation (6%).

The European Investment Bank (EIB) issued the first "labeled" green bond (Euro 600 million) in 2007. The World Bank followed the EIB and issued its first green bond in 2008. As of May of 2017, the World Bank group issued around US$10 billion equivalent in green bonds through more than 130 transactions in 18 currencies.[5] Green bonds issued by supranational institutions are primarily AAA-rated securities.

In late 2013, corporations entered the market using the World Bank and the EIB's model. The first publicly traded corporation to issue a green bond was Electricite de

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[3] Green projects are defined as projects that promote environmental sustainability such as reduction in greenhouse gas emissions, investment in renewable energy and clean transportation technology.

[4] Tobin's Q is a proxy for forward-looking growth opportunities, while asset growth is a historical measure of firm growth.

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[5] http://treasury.worldbank.org/cmd/htm/GreenBondIssuancesToDate.html.

Fig. 1 Growth in green bond market. *Source*: Climate Bonds Initiative
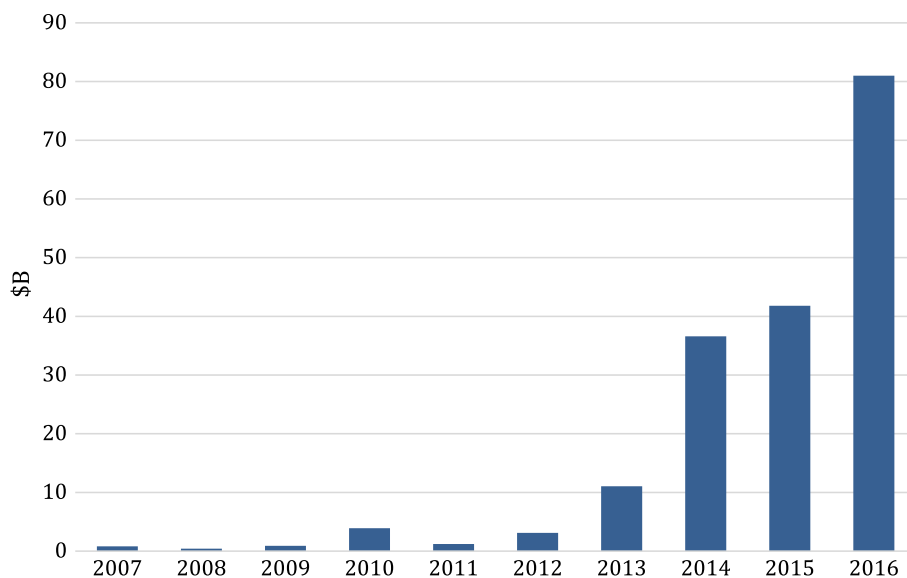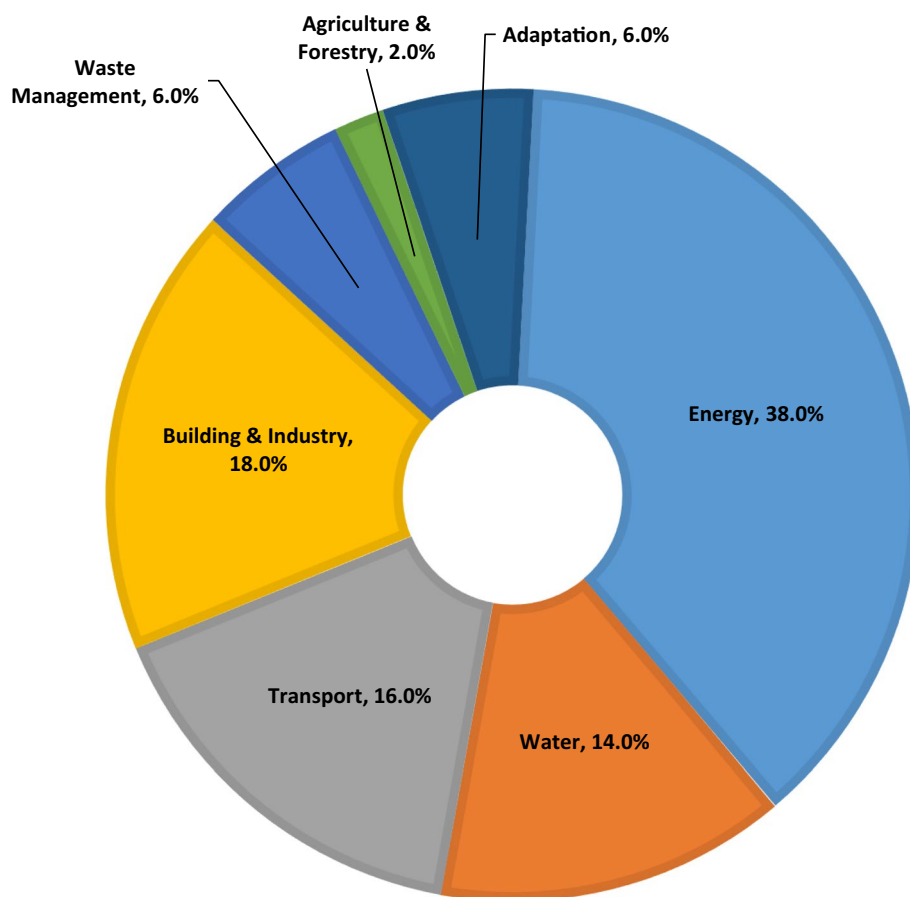

Fig. 2 Green bond proceeds for 2016. *Source*: Climate Bonds Initiative

France (EDF in November 2013).[6] EDF issued €1.4b (US $2.0142b), 2.25% coupon with 7.5 years to maturity with

the proceeds being utilized for renewal projects. The bond is rated A+ by S&P, two times oversubscribed, and received a second opinion from French ESG rating company VIGEO for its green bond eligibility criteria. The first US publicly

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[6] Credit Agricole Corporate and Investment Bank, a subsidiary of Credit Agricole SA (publicly listed), was the first commercial bank to issue green bonds in January 2013. We did not include Credit Agricole in the sample since it has multiple announcements each year since 2013. This contaminated the market model estimation window.

listed firm to issue green bonds is Bank of America (BoA).[7] BoA viewed its $500m green bond issuance as an opportunity to expand its investor base and to support an important market as investors seek more socially responsible investment options.[8]

Buyers of the green bonds are typically large institutions such as pension funds. A very small proportion trades on the secondary market, where individual investors may buy them (Blackwell 2014). For example, according to Climate Bond Initiative, investors that integrate ESG criteria into their investment decisions bought 60% of EDF's green bonds. Participants in the issue included fund managers (70%), insurance and pension funds (13%), central banks (13%), and banks and others (4%). However, retail investors can participate indirectly through their pension fund or through funds with ESG mandates or socially responsible investing mutual funds.

The ultimate defining feature of green bonds is the utilization of the proceeds, which supports verifiable projects that are intended to alleviate climate or environmental impact. A standard approach of designating a project as "green" did not exist until 2014. In early 2014, a group of 13 banks drew up a set of voluntary guidelines that recommend transparency and disclosure as well as to promote integrity in the development of the green bond market by clarifying the approach for issuance of a green bond. The Green Bond Principles (GBPs) include guidelines for: use of proceeds, process for project evaluation and selection, management of proceeds and reporting.[9] The structure of green bonds is classified as: green use of proceeds bond, green use of proceeds revenue bond, green project bond, or green securitized bond.

Related literature

This study is related to the corporate social responsibility (CSR) literature and the socially responsible investing (SRI) literature. CSR investments center around value enhancement and risk management. There are several studies which show that superior CSR performance is linked to better stakeholder engagement and the likelihood of short-term opportunistic behavior is limited (Benabou and Tirole

2010; Eccles et al. 2012). Also, Lee and Faff (2009) find that high CSR scores lead to lower idiosyncratic risk. Similarly, Ioannou and Serafeim (2010) show a positive relationship between CSR score and sell-side analyst recommendations. In addition, Goss and Roberts (2011) show that firms with weaker social responsibility scores pay between 7 and 18 basis points more for bank loans. Along a similar line of investigation, Dhaliwal et al. (2011) show that voluntary disclosure of CSR activities leads to lower cost of capital, while El Ghoul et al. (2011) find that firms with better CSR scores have lower cost of equity.

There are some studies that examine the announcement effects of corporate news on environmental issues. Negative environmental news results in negative stock price reaction (Klassen and McLaughlin (1996), Hamilton (1995) and Dasgupta et al. (2001)). Firms with stringent environmental standards have higher firm value (Dowell et al. 2000; Derwall et al. 2004).

There are several empirical studies that examine the financial performance of socially responsible investment funds (SRI). They find that there is no significant difference in the returns of relatively more socially responsible funds compared to conventional funds (see for, e.g., Hamilton et al. 1993; Statman 2000; Bauer et al. 2005; Bello 2005). In fact, Johnsen (2003) argues that the size of SRI funds is usually too small for the fund's portfolio decisions to have an impact on the firm's behavior. In addition, Heinkel et al. (2001) find that at least 25% of green investors are required to induce any polluting firms to reform.

Given that the green bond market is being utilized by publicly traded corporations as a source of financing and that the market is poised to grow rapidly, an empirical examination of this market warrants investigation. The objective of this research is to examine stock market reaction to the issuance of green bonds by publicly traded corporations. In addition, using cross-section analysis, the paper aims at identifying both bond and firm characteristics that explain the market reaction to green bond issuance. This study will add to our understanding of how capital markets can play a role in the fight against climate change.

Data, methodology, and descriptive statistics

Data

I hand-collected announcement dates for green bonds issued by publicly listed corporations using newspaper articles and company press releases. Firm and market return data around the announcements, along with stock prices and accounting information are obtained from the Factset database. I require that firms have at least 250 trading days returns data prior to

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[7] Announcement date November 21, 2013.

[8] Buyers of BoA green bonds include: AP4, BlackRock, Breckinridge Capital Advisors, California State, Teachers' Retirement System, Calvert Investment Management, Pax World Management, Praxis Intermediate Income Fund, State Street Global Advisors, Standish Mellon Asset Management Company, TIAA-CREF and Trillium Asset Management (BoA Nov. 21, 2013 Press Release).

[9] The green bond principle has been updated in 2016.

the announcement date and 10 days following the announcement. The initial sample contains 72 publicly traded firms that issued green bonds. Firms with less than \$5 billion in market capitalization are dropped from the sample in order to eliminate the small firm effect or "penny" stock effect. I also dropped firms that have confounding events within the test window of − 10 to + 10 days around the announcement of green corporate bond issuance. The final sample is 54 firms with the majority of the corporate green bonds issued by corporations that are domicile in Europe. There is one Canadian corporate green bond issued (TD bank) and 10 US corporate green bonds, with Bank of America being the first to utilize this segment of the bond market. Chinese firms entered this market in July 2015 with Xinjiang Goldwind Science and Technology with \$300m. As of December, 2016, there are 8 Chinese and 3 Australian issuers in the sample.

Methodology

In this paper, I utilized the standard event study methodology. Following Brown and Warner (1985) and others, I estimate the following market model (Eq. 1) for expected returns for each firm based on the daily returns from day − 250 through − 21 (where day 0 is the green bond issue announcement date)[10]:

$$R_{i,j,t} = \propto_i + \beta_i R_{m,j,t} + \varepsilon_{i,t}, \tag{1}$$

where $R_{i,j,t}$ is the return of firm i in country j on day t and $R_{m,j,t}$ the market returns for country j on day t. Also, I estimate a market model with the domestic market index and the global market index (MSCI world index).

I then use the parameter estimates from the market model, individual stock and market returns to estimate the abnormal returns (Eq. 2) over the event window (controlling for beta). Thus, the abnormal returns for firm i in country j on day t is estimated as:

$$AR_{i,j,t} = R_{i,j,t} - \hat{\propto}_i g + \hat{\beta}_i R_{m,j,t} \tag{2}$$

The cumulative abnormal returns (CAR) is examined using Eq. (3) below:

$$CAR_i = \alpha + \gamma' \mathbf{X} + \delta' \mathbf{Y} \tag{3}$$

where CAR_i is the cumulative abnormal returns for firm i. The vector $\mathbf{X}$ comprises of several bond characteristics such as oversubscription, second review, bond ratings, coupon,

and maturity. Maturity is defined as the log of time to maturity, coupon is the coupon rate, oversubscription is an indicator variable equal to 1 if the issue is oversubscribed and zero otherwise. Second review is an indicator variable equal to 1 if the green bond is certified and reviewed by an ESG rating company such as VIEGO and zero otherwise. Bond ratings are a binary variable equal to 1 if the bond is rated A- and above and zero otherwise.

Oversubscription is important in the model as it measures the demand of green bonds from market participants. It is possible that market reaction is stronger for green bonds that have stronger demand. In addition, second review from a non-credit rating agency signals to the market that the green bonds received an independent agency certification that the bond proceeds will be used in accordance with the green bond principles. Market participants are expected to react more positively to green bonds that received certification relative to those without certification. Furthermore, I include bond ratings since Kliger and Sarig (2000) show that bond ratings contain information relevant for pricing. Also, since a majority of green bonds are privately placed, obtaining pricing information such as yield to maturity is difficult. Therefore, I used coupon rate as a proxy for cost of debt. Finally, it is possible that the market reaction is different for short-term bonds compared to longer-term bonds. Hence, maturity is utilized as an explanatory variable in Eq. (3).

Following the CSR literature, in the vector $\mathbf{Y},$ I control for several firm characteristics such as firm size, cash flow ratio, financial leverage, profitability, Tobin's Q, and asset growth. For example, Eccles et al. (2012) and Goss and Roberts (2011) control for size, profitability, and leverage. Furthermore, the stock market may react negatively to firms with strong operating cash flow due to agency problems of free cash flow. Managers can potentially misuse or expropriate excess free cash flow. Finally, our growth measures (asset growth and Tobin's Q) are used to test whether the market believes that firms are using green bond financing to invest in sustainable value-added projects.

Firm size is defined as the log of total assets. Cash flow ratio is operating cash flow divided by total assets and financial leverage is total debt divided by total assets. Profitability is defined as return on assets (EBIT/total assets), Tobin's Q is market value of equity + book value of debt divided by total assets and asset growth is 5-year geometric growth in total assets. All of the accounting variables are measured as of the fiscal year prior to the announcement. The market capitalization is 1 month prior to the announcement date.

Summary statistics and univariate tests

The first corporate green bond, Electricite de France (EDF), was announced on Nov. 12, 2013 for €1.4b with a 2.25% coupon rate. The maturity of the bond is 7.5 years, and it is

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[10] Utilizing an estimation window approximately 1 year prior to the event date to estimate the parameters of the market model is a common practice. For example, Klassen and McLaughlin (1996) utilized a 200-day estimation window while Dasgupta et al. (2001) used an estimation window from − 120 to − 210 days prior to the event date.

rated A+ by S&P. The bond was oversubscribed by $2\times$ and is certified by VIGEO. At the end of May 2015, EDF completed the full allocation of the €1.4b. The funds contributed to financing 13 renewable energy projects in France and North America.[11] Following its first successful green bond, EDF issued a second green bond on October 8, 2015 for $1.25b with 3.625% coupon rate and 10-year maturity. The bond is A+ rated. Like the first green bond, projects financed by this issuance have to meet certain environmental and social conditions set by the non-financial rating agency VIGEO. Ever year the company is committed to disclose in its reference documents the list of those projects selected to receive financing from the green bond proceeds.

Most of the green bonds are issued by European firms excluding UK firms (33.33%), followed by US firms (18.5%), and Chinese firms (14.8%). Green bonds are typically issued by utilities, power generation, and green technology companies. However, real estate companies, banks, and automakers have all issued green bonds. For example, Toyota issued green bonds to finance car loans for hybrid electric vehicles. Similarly, the Toronto Dominion bank used the proceeds from its green bond issuance to finance customers or its own projects or operations that support the green economy.

In Table 1, panel A, I report summary statistics for firm characteristics in US dollars for the sample. The accounting data is converted to US dollars using the fiscal year end exchange rate reported by Factset. In terms of total assets, the mean (median) is $544.2b ($99.19b) with a minimum $5.53b and a maximum of $2.654 trillion. The largest firm by assets is Mitsubishi UFJ Financial group followed by HSBC with $2.634 trillion in assets. The average firm size measured by total assets is skewed by large global financial institutions. In fact, the top ten largest firms are all financial institutions with total assets of over $20 trillion. Using sales as proxy for firm size, the mean (median) is $55.3b ($31.66b). The largest firm in the sample, using sales as a measure, is Toyota with $266.1b in sales for fiscal year 2013 followed by Apple with $232.7b in sales in 2015. As for operating profit, the mean (median) earnings before interest and taxes (EBIT) is $7.17b ($3.15b). Mean (median) return on assets is 4% (3%). The minimum ROA is 0.32%, while the maximum is 23%.

In terms of total debt, the mean ($385.15b), like total assets, is skewed by financial institutions in the sample. Furthermore, on average, 66% of firms' assets are financed by debt, while median leverage ratio is 66%. The minimum financial leverage is 29%, while the maximum is 92%. The

Table 1 Summary statistics

US$	Mean	Median	SD	Min	Max
Panel A: Firm characteristics					
Total assets $B	544.20	99.19	807.23	5.53	2654.06
Market Cap. $B	62.59	34.67	86.33	5.02	539.97
Sales $B	55.30	31.66	68.06	1.08	266.13
EBIT	7.17	3.15	11.38	− 0.20	66.63
Return on assets–%	0.04	0.03	0.04	0.00	0.23
Total debt	385.15	67.71	593.89	1.75	2273.34
Financial leverage–%	0.66	0.66	0.15	0.29	0.92
Growth (total assets)–%	0.05	0.03	0.08	− 0.06	0.42
Tobin's Q	1.15	1.02	0.44	0.45	2.45
Cash flow/total assets–%	0.06	0.05	0.05	− 0.01	0.28
Panel B: Green bond characteristics					
Second review–%	62.96	100.00	48.74	0.00	100.00
A-rated bonds–%	44.44	0.00	50.16	0.00	100.00
Investment grade–%	66.67	100.00	47.58	0.00	100.00
Oversubscription–%	33.33	0.00	47.58	0.00	100.00
Maturity–years	6.18	5.50	2.50	3.00	10.00
Amount issued $m	872.41	533.90	893.60	48.60	4400.00
Coupons–%	2.49	2.24	1.82	0.13	9.55
Fixed coupon only–%	2.47	2.50	1.58	0.13	8.85

Growth is the 5-year geometric growth rate in total assets; financial leverage is defined as total debt divided by total assets. Return on assets (ROA) is equated to EBIT/total assets. Tobins' Q is defined as (market value of equity + (total assets minus book value of equity)) divided by total assets. Cash flow/total assets are equaled to operating cash flow divided by total assets. Second review is an indicator variable equal to 1 if the proposed use of fund is certified by an independent organization or zero otherwise. A- rated is a dummy variable equal to 1 if the bond is A- rated or above and zero otherwise. Investment grade is a binary variable equal to 1 if the bond is rated BBB- or above and zero otherwise. Oversubscription is an indicator variable equal to 1 if the bond is oversubscribed to by investors and zero otherwise. Maturity is the number of years to maturity. Coupon is the promised coupons and includes floating rate coupons. For the floating rate, the rate on the issue date is used to estimate the coupon rate. Fixed coupon only is the fixed coupon green bonds

*, ** and *** denote statistical significance at the 10%, 5% and 1% level, respectively

maximum is expected since financial institutions are highly leveraged firms with less than 10% common equity.

In panel A, I also report firm growth and Tobin's Q ratio to proxy for growth opportunities. Firm growth is measured as the geometric mean growth rate in total assets over 5 years. The mean (median) growth rate is 5.0% (3.0%) with a minimum and maximum growth rate of − 6.0% and 42%, respectively. The mean (median) Tobin's Q ratio is 1.15 (1.02). Finally, on average, firms have 6.0% of total assets in the form of net operating cash flow.

In Table 1, panel B, I present several bond characteristics for the sample. The majority of the firms issuing green bonds

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Table 2 Abnormal returns

%	Mean	Median	SD	Min	Max	t-stat
Announcement day returns	− 0.17	− 0.21	1.04	− 2.29	1.80	− 1.21
CAR − 10 to 10	1.48	1.65	4.45	− 6.93	9.61	2.45**
CAR − 10 to 20	1.46	1.92	6.09	− 11.00	16.81	1.76*
MSCI CAR − 10 to 10	1.42	1.56	4.55	− 7.773	9.39	2.29**
MSCI CAR − 10 to 20	1.33	2.26	6.01	− 10.94	14.19	1.68*

The abnormal returns are estimated using a market model and the market model with both the domestic stock index returns and the MSCI world index returns

*, ** and *** denote statistical significance at the 10%, 5% and 1% level, respectively

Fig. 3 Cumulative abnormal returns over − 10 to + 20-day window
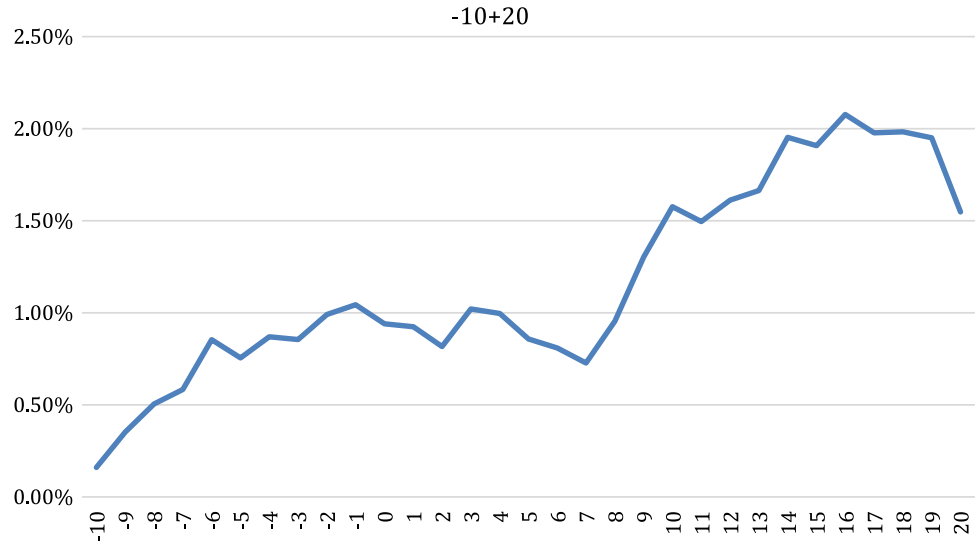
(mean = 63% and median = 100%) requested a second review or certification of the bond by an independent non-financial rating agency such as VIGEO. As for credit ratings, 44.44% of the bonds are rated A- and above by a rating agency such as S&P. While 22.22% are rated BBB to B-, 33.34% of the bonds are not rated. Overall, 66.67% of the bonds are rated investment grade.

In terms of investor demand, 33.33% of the bonds are oversubscribed. Oversubscription ranges from 1.5x to 6.8x. For example, in 2015, Societe Generale received €3b in orders for its €500m green bonds. In addition, the average (median) maturity for bonds in the sample is 6.18 years (5.50 years) with the shortest maturity being 3 years and the longest being 10 years. Also, the mean (median) amount of green bond financing raised is $872.41m ($533.9m).[12] The smallest amount is $48.6m issued by Yes Bank in 2016 to fund solar and wind projects. The largest green corporate bond issued is $4.4b (RMB 30b) by Bank of Communications in 2016 to finance energy savings, clean energy transportation, ecological protection, and recycling. Finally, the mean (median) coupon rate is 2.49% (2.24%). In the

sample, 11.11% of the green bonds have a floating rate coupon. The remainder has a fixed rate coupon. Fixed coupon only (88.89% of the sample) has a mean (median) of 2.47% (2.50%).[13] Societe Generale 2015 green bond has the lowest fixed coupon (0.125%), while Yes Bank has the highest fixed coupon rate (8.85%) in the sample.

Results

Cumulative abnormal returns

The announcement day abnormal returns as well as the cumulative abnormal returns (CAR) are reported in Table 2. The mean announcement day abnormal returns is − 0.17% and not statistically significant. It is possible that there is information leakage and hence, the announcement day returns are small and insignificant. The press releases or news articles usually occur after the bonds have been sold. Therefore, the information may have leaked to the

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[12] Amount issued is converted to US dollars at an exchange rate at the time of the announcement.

[13] For firms that issue floating rate coupons we use the interest rate for the floating rate benchmark as of the announcement date.

Table 3 Regression of cumulative abnormal returns on bond and firm characteristics

	I		II		III		IV	
	Coef.	*t*-stat	Coef.	*t*-stat	Coef.	v-stat	Coef.	*t*-stat
Oversubscription	− 0.017	− 0.98	0.002	0.10	− 0.016	− 1.05	− 0.001	− 0.04
Log of maturity	− 0.001	− 0.06	− 0.016	− 1.01	0.004	0.30	− 0.012	− 0.79
Coupon	− 0.830	− 1.69*	− 0.890	− 1.96**	− 0.890	− 2.25**	− 0.936	− 2.22**
Second review	0.012	0.70	0.017	1.03	0.018	1.25	0.021	1.33
A-rated bonds	− 0.004	− 0.28	− 0.023	− 1.39	− 0.009	− 0.65	− 0.024	− 1.47
CF ratio	− 0.523	− 2.40**	− 0.595	− 2.32**	− 0.376	− 2.03**	− 0.567	− 2.21**
Firm size	0.007	1.38	0.016	2.44**	0.006	1.46	0.015	2.60**
Financial leverage	− 0.020	− 0.38	− 0.037	− 0.42	− 0.002	− 0.05	− 0.026	− 0.33
ROA	− 0.753	− 1.50	− 0.131	− 0.29	− 0.629	− 1.45	− 0.064	− 0.15
Tobin's Q	0.106	3.42***	0.098	1.92*	0.077	3.37***	0.084	1.84*
Growth	0.233	1.69*	0.267	2.41**	0.223	1.96**	0.262	2.48**
Intercept	− 0.057	− 1.45	− 0.071	− 1.33	− 0.054	− 1.52	− 0.073	− 1.42
R^2	31.94%		35.65%		32.58%		36.20%	
Obs.	54		54		54		54	

The dependent variable in columns I and II is the cumulative abnormal returns of the − 10 to 10 window and − 10 to 20 window using the domestic market index. The dependent variable in columns III and IV is the cumulative abnormal returns of the − 10 to 10 window and − 10 to 20 window using the domestic market index and MSCI world index returns. Oversubscription is an indicator variable equal to 1 if the bond is oversubscribed to by investors and zero otherwise. Maturity is the number of years to maturity. Coupon is the promised coupons. Second review is an indicator variable equal to 1 if the proposed use of fund is certified by an independent organization or zero otherwise. A-rated bonds are a dummy variable equal to 1 if the bond is A- rated or above and zero otherwise. CF ratio = operating cash flow/total assets. Firm size is the log of total assets. Financial leverage = total debt divided/total assets. Return on assets (ROA) is equaled to EBIT/total assets. Tobin's Q is defined as (market value of equity + (total assets minus book value of equity)) divided by total assets. Growth is the 5-year geometric growth rate in total assets

*, ** and *** denote statistical significance at the 10%, 5% and 1% level, respectively

market especially for those firms that have a second review prior to the bond issuance. As a result, it is important to examine the abnormal returns prior to the announcement date and over a longer period. In Fig. 3, I report the cumulative average abnormal returns over the − 10 to + 20 event window. It is evident that there are positive abnormal returns prior to the announcement date. For example, CAR increased from 0.50% on day − 8 to just over 1% on day − 1 and remained close to 1% until day + 7. From day + 7 to day + 16, there is a significant increase in the CAR.

In Table 2, the 21-day CAR (− 10 to 10) is economically and statistically significant at the 5% level. The mean (median) CAR is 1.48% (1.65%) with a minimum of − 6.93%, while the maximum is 9.61%. The CAR (− 10, + 20) is positive and significant at the 10% level. In addition, I report the cumulative abnormal returns using a market model with both the domestic market index and a global market index (MSCI world index). The results are similar to the CAR using only the domestic index in the market model. For example, the MSCI CAR (− 10, + 10) is positive and significant at the 5% level with a mean (median) CAR of 1.42% (1.56%). The results, based on the cumulative abnormal returns, imply that green bonds

issuance is value added which means that green bonds are used to fund growth opportunities and/or risk mitigation. Hence, shareholders react positively to their issuance.

Regression analysis

In Table 3, I report the regression results for several bond and firm characteristics on the cumulative abnormal returns. In column I (CAR − 10, + 10) and II (CAR − 10, + 20), the cumulative abnormal returns are calculated using the domestic market index only, whereas in columns III and IV, the CAR is estimated using both the domestic market index and the MSCI world market index. Regardless of the measure of CAR, coupon rate is the only bond characteristic that is statistically significant. For example, higher coupons resulted in lower abnormal returns. Using coupon rate to proxy for cost of debt, the negative coefficient implies that the market reaction is lower for firms with higher cost of debt. This is consistent with the argument that higher coupons signals managers' commitment to maintain a stable level of cash flow, and as a result, the market reaction is lower for green bonds issuing firms.

Table 4 Test of differences in risk before and after green bond announcement

	Mean	Median	SD
Beta before	0.99	1.01	0.34
Beta after	0.79	0.76	0.54
Test for difference	− 3.26***	− 2.88***	
Total risk before	1.73	1.61	0.64
Total risk after	1.54	1.51	0.50
Test for differences	− 2.16**	− 1.79*	

Beta is estimated using Eq. 1. Total risk is the standard deviation of daily returns 1 year before the announcement and 1 year after the announcement

In terms of firm characteristics, several are statistically significant with the expected sign. The operating cash flow (cash flow/total assets) is negative and significant across all different measures of CAR. For example, using the − 10, + 10 day window, the cash flow ratio is negative and significant at the 5% level. That is, firms with strong operating cash flow elicit a weaker investor reaction. In addition, using estimated coefficient in column I, a one standard deviation change in cash flow ratio resulted in a 2.62% decline in CAR. This is consistent with the expectation that firms with strong operating cash flow will utilize their internal funds before accessing external financing. In terms of firm size, it is positive and significant at the 5% level for CAR − 10, + 20 in columns II and IV. This implies that the market reaction is stronger for the issuance of green bonds when the firms are larger.

Growth opportunities are proxied by Tobin's Q and growth in total assets. I include two measures of growth because Tobin's Q is a forward-looking measure of growth, while total asset growth rate is a historical measure.[14] Tobin's Q is positive and significant across all measures of CAR (columns I to IV). In column I, for example, Tobin's Q is positive and significant at the 1% level. Also, a one standard deviation change in Tobin's Q ratio results in a 4.66% increase in the CAR (− 10, + 10).

Using total asset growth as proxy for growth opportunities, investors react stronger to green bond issuance for firms with more growth opportunities. Asset growth is positive and significant across all different measures of CAR. For example, using CAR − 10, + 20 (column II), a one standard deviation change in asset growth leads to a 2.14% increase in abnormal returns. This implies that green bond issuing firms with growth opportunities elicit a stronger market reaction. This is consistent with the hypothesis that firms are issuing green bonds to finance growth opportunities and not simply

issuing green bonds in order to garner financing from the socially responsible segment of the capital market.

In order to examine whether green bond reduces risk, I conducted before and after analysis using beta and total risk.[15] I estimate beta before and after the announcement using Eq. (1) and daily stock and market returns from day + 21 to + 250 (after) and from day − 21 to − 250 (before). In Table 4, I conducted mean and median tests for the difference in beta before the announcement and after the announcement. Beta after the announcement is lower than beta before the announcement and statistically significant. Also, I estimate total risk (standard deviation of daily returns) using the same estimation window as beta. Tests for difference in mean and median are statistically significant. The results using both measures of risk imply firm risk decline following green bond issuance. Hence, it is possible that firms' environmental and reputational risk declines as a result of the green bond issuance.

Robustness check

It is possible that the results differ across countries with different shareholder protection. As a result, I conducted sub-sample analyses using civil and common law countries.[16] The univariate test shows no difference in abnormal returns for green corporate bond issuers from civil law countries compared to common law countries. Next, I include a dummy variable for common law in the cross-section regression and the coefficient is not statistically significant at conventional levels (results not tabulated).

Conclusions

Environmental sustainability is becoming either a driver of new business opportunities and/or a key consideration in mitigating economic, regulatory, and reputational risk. In addition, environmental impact and sustainability of projects as well as societal impact are becoming a key consideration in portfolio investment decisions by institutional investors such as pension funds. A relatively new financial instrument aimed at environmental sustainability is being utilized by supranational organizations, governments, municipalities, and publicly traded corporations. Hence, an examination of the impact of this instrument is warranted. This study investigates the stock market reaction to news announcements of green bonds issuance by publicly traded corporations. Using

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[14] As the referee pointed out, it is possible that Tobin's Q also indicates potential assets substitution risk.

[15] I thank the referee for suggesting that I examine firm risk before and after the announcement.

[16] I thank the referee for suggesting that I look at countries with different shareholder protection.

a market model, the cumulative abnormal returns are positive and statistically significant. In addition, several bond and firm characteristics explain the announcement effects. Green bonds issued with higher coupon rates elicit a negative market reaction. Additionally, firm size, Tobin's Q, and asset growth are positively related to the cumulative abnormal returns, while operating cash flow is negatively related to the CAR. Finally, I show that firm risk decline following green bond issuance, both beta and total risk.

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