

Short and Long Effects of Green Bonds

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Abstract: Corporate green bond has been increasingly prevalent over time as a symbol of environment-friendly projects and companies' environmental awareness. Using data of public corporate in and analyzing them, we found that stock prices have a positive relationship with issuance of green bond in the short term and in the long run companies who issued green bonds conduct better performances towards environment.

Keywords: Green bond, Economic benefit, Environmental protection.

1. Introduction

As a prevalent way of raising money for climate and environmental projects, green bonds issuance has been experiencing rapid development due to increasingly severe ecological problems and companies' other profound considerations. Green bonds are generally defined as designated bonds intended to encourage sustainability and to support climate-related or other types of special environmental projects. More specifically, green bonds finance projects aimed at energy efficiency, pollution prevention, sustainable agriculture, fishery and forestry, the protection of aquatic and terrestrial ecosystems, clean transportation, clean water, and sustainable water management. They also finance the cultivation of environmentally friendly technologies and the mitigation of climate change. For instance, green bonds are employed to finance energy efficiency projects, renewable energy projects, pollution prevention and control projects, natural resources and land management projects, clean transportation projects, wastewater and water management projects and green building projects.

As recently as 2012, green bond issuance amounted only to \$2.6 billion. But in 2016, green bonds began to sprout. Much of the action was attributable to Chinese borrowers, who accounted for \$32.9 billion of the total, or more than a third of all issuances. But the interest is global, with the European Union and the United States among the leaders too.

In 2017, green bond issuance soared to a record high, accounting for \$161 billion worth of investment worldwide, according to the latest report from the rating agency Moody's. Growth slowed a bit in 2018, hitting only \$167 billion, but rebounded the following year thanks to an increasingly climate-aware market. Green issuance reached a record \$266.5 billion in 2019, and nearly \$270 billion the following year. The 2010s saw the development of green bond funds, broadening the ability of retail investors to participate in these initiatives. Allianz SE, Axa SA, State Street Corporation, TIAA-CREF, Blackrock, AXA World Funds, and HSBC are among the investment companies and asset management firms that have sponsored green bond mutual funds or ETFs.

The constantly rising popularity of green bonds is driven primarily by investors embracing socially responsible investing, and not a better risk and return potential over conventional bonds. With that said, green bonds may offer tax incentives (depending on the issuer and jurisdiction), such as tax exemption and tax credits. It is done to attract investors to

finance projects that benefit the environment and/or climate.

I read relative essays and found that these essays mainly concentrate on the effects of green bonds on companies' response in the long-term using difference in difference (DID). They reach the conclusion that investors respond positively to the issuance announcement and environmental performance goes up sustainability in the long run. Besides, to measure firms' environmental performance, the researcher adopted the environmental rating from ASSET4 and the ratio of CO2 emission divided by the book value of assets. The formula is as follows:

$$y_{it} = \alpha_i + \alpha_c \times \Delta t + \alpha_s \times \Delta t + \beta \times \text{Green bond}_{it} + \epsilon_{it}$$

These researches provide me with an inspiration of studying the relationship between issuance of green bonds and firms' environmental performances. Nevertheless, the two measure of firms' environmental performance may not be such representative as to those firms who rely on non-carbon resources or those who discharge waste water to river secretly. What's more, according to the definition of green bonds, its issuance can help to attract investors, so in this paper, I will also study the impact of issuing green bonds on the stock price.

To start the research, we collect public companies' stock price and data of their environmental performance in the year 2018 and to examine if issuing green bonds has any impact on companies' stock prices more straightforwardly, we adopt regression discontinuity design (RDD), where the date of issuing green bonds is the discontinuity point. Using these data and method, we reach the result that at the date of issuing green bonds, there exists a temporary increase in companies' stock prices.

As only a few researches study the short-term effects of issuing green bonds on the stock price, our study could offer a reference to people who show interest in this aspect. Our study on the long-term impact of issuing green bonds on firms' environmental performance also examine the outcome of previous essays. Although issuing green bonds does raise stock prices and this shows that green bonds issuance can help companies attract investors, the higher stock price does not keep for a long period and even experiences a decrease compared to that before issuance. Many reasons exist behind such a phenomenon, among which inadequate government support can also be attributed to. We hope that government could encourage issuing green bonds more with for example, more funds and heavier tax incentives.

2. Background

Compared with common bonds, the speciality of green bonds exists in four aspects, which are the aim of collecting public funds, the assessment and choice of green projects, follow-up management of the raised fund and requiring the issuance of relevant annual reports. Actually, the definitions of green bonds home and abroad differ a little, but the consensus is that the funds collected in the name of green bonds shall be employed in green projects or assets. Such a definition raises two assumptions, first, as the environmental protection policy is high on the agenda, chances are that the issuance of green bonds can attract a certain of investors. Second, once a firm issued green bonds, the environmental performance would be improved. At the thought of these two probable outcomes, we start to verify them.

3. Literary Review

Caroline Flammer examines how the stock market responds to the issuance of green bonds and the evolution of various firm-level outcomes following the issuance of green bonds, and he finds that investors respond positively to the issuance announcement, a response that is stronger for first-time issuers and bonds certified by third parties. The issuers improve their environmental performance post-issuance (i.e., higher environmental ratings and lower CO2 emissions) and experience an increase in ownership by long-term and green investors. Our research also find that issuing green bonds can attract investors and the issuers would improve their environmental performances. Caroline Flammer adopts an event study methodology to study the reaction of investors, in contrast, we use regression discontinuity design (RDD) to examine the same question, and we collect the stock prices in the year 2018 only to reflect the investments. When it comes to the environmental behaviors, instead of collecting data about their environmental ratings and CO2 emissions directly, we observe their expense in energy conservation and emission

reduction, investment in green projects, patents for environmental protection projects and so on. Through the above methodology, we study the long-term and short-term effects of issuing green bonds on public companies. What's more, since Caroline Flammer found that the response of investors is stronger for first-time issuers, we also come up with a question whether the stock prices, which we regard as a symbol of investors' response, would gradually decrease as time goes by. This question would be answered simultaneously with the above two assumptions.

4. Method and Data

This research is divided into two main parts, which are the short-term effects of issuing green bonds and the long-term effects. To study the short-term effects, we use the stock price of public companies as a measure and collect the stock prices of all listed companies that issued green bonds in 2018. We set the date of issuing green bonds as the discontinuity point and carry out regression analysis on stock prices. As for the long-term effects, we used DID model to analyze that whether green bond issuance has an impact on operating revenue. The basic idea of the DID model is to construct the differential statistics reflecting the policy effect by comparing the differences between the control group and the treatment group before and after the implementation of the policy. In this analysis, before and after the issuance of green bond are the treatment group and the control group. And we collected data on pollution emissions, green patent applications, investment climate, operating revenue and so on from 300 listed companies from 2010 to 2020 to conduct empirical analysis.

5. Results

First, I respectively describe the stock prices before and after the issuance of green bonds and get the below table. We can find that the average stock price before is higher than the price after, which is beyond our expectations.

Table 1. Regression analysis results table

| Variable | Obs | Mean | Std. Dev. | Min | Max |
|----------|------|-----------|-----------|-------|--------|
| price | 4863 | 16.187 | 18.593 | 2.09 | 132.09 |
| date | 4863 | 21316.353 | 91.061 | 21186 | 21543 |
| Variable | Obs | Mean | Std. Dev. | Min | Max |
| price | 3694 | 14.216 | 17.943 | 2.13 | 125.49 |
| date | 3694 | 21436.295 | 81.966 | 21201 | 21546 |

Then I perform regression discontinuity design, where the numbers on the horizontal axis represent the difference between the date of issuance and that date, and the numbers on the vertical axis are the stock prices. Observing the below two graphs, we can conclude that there exists an obvious

increase in stock price at the date of issuing green bonds, but the higher stock prices do not keep a long period and become even lower than before. This conclusion match the descriptive statistics and also our assumption that investors response positively to the issuance of green bonds.

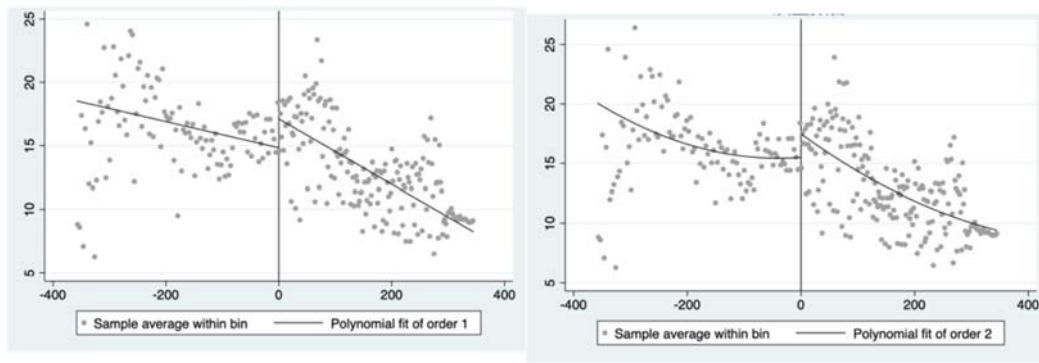


Figure 1. Scatter diagram of the sample

In the long-term study, we collected operating revenue from 2010 to 2020 of 300 companies. Unfortunately, only 650 data were available. We can only use the available data to analyze whether green bond issuance has an impact on operating revenue. Operating revenue is the explained variable, before and after the issuance of green bonds is set as the dummy variable, and other factors such as pollution emission are the control variables. The following figure shows individual regression analysis and fixed-effect regression analysis respectively.

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. reg OperatingRevenueYuan did
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| Source | SS | df | MS | Number of obs = | 650 |
|----------|------------|-----|------------|-----------------|-----------|
| Model | 2.7636e+22 | 1 | 2.7636e+22 | F(1, 648) | = 10.54 |
| Residual | 1.6996e+24 | 648 | 2.6229e+21 | Prob > F | = 0.0012 |
| Total | 1.7272e+24 | 649 | 2.6614e+21 | R-squared | = 0.0160 |
| | | | | Adj R-squared | = 0.0145 |
| | | | | Root MSE | = 5.1e+10 |

| OperatingR-n | Coefficient | Std. err. | t | P> t | [95% conf. interval] |
|--------------|-------------|-----------|------|-------|----------------------|
| did | 1.40e+10 | 4.31e+09 | 3.25 | 0.001 | 5.52e+09 2.24e+10 |
| _cons | 2.35e+10 | 2.44e+09 | 9.64 | 0.000 | 1.87e+10 2.83e+10 |

Figure 2. Regression analysis results table of operating revenue

From the individual regression analysis, we can know that p-value is very small which means that the individual result is significant. The R-squared is too small and the goodness of fitting is not good enough.

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. xtreg OperatingRevenueYuan did , fe
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Fixed-effects (within) regression
Group variable: listid

Number of obs = 650
Number of groups = 66

R-squared:
Within = 0.1303
Between = 0.0151
Overall = 0.0160

Obs per group:
min = 1
avg = 9.8
max = 11

corr(u_i, Xb) = -0.0473
F(1,583) = 87.32
Prob > F = 0.0000

| OperatingR-n | Coefficient | Std. err. | t | P> t | [95% conf. interval] |
|--------------|-------------|-----------------------------------|-------|-------|----------------------|
| did | 1.87e+10 | 2.00e+09 | 9.34 | 0.000 | 1.48e+10 2.26e+10 |
| _cons | 2.20e+10 | 1.10e+09 | 19.99 | 0.000 | 1.98e+10 2.41e+10 |
| sigma_u | 4.572e+10 | | | | |
| sigma_e | 2.280e+10 | | | | |
| rho | .80080699 | (fraction of variance due to u_i) | | | |

F test that all u_i=0: F(65, 583) = 41.31
Prob > F = 0.0000

Figure 3. fixed-effects regression of operating revenue

Obviously, the result of this experiment was significant for a long period. The P-value showed that the results were significant, the coefficient is positive. Therefore, the issuance of green bond has a positive effect on operating revenue. As

for how to improve the empirical results, I think we need more data on operating revenue and other controlled variables. Because there are so many factors that can affect the operating revenue, and what we have collected just a few data. Thus, to get more accurate empirical results, we should take into account all the factors that affect the operating revenue.

6. Political Advice

Reaching the above outcomes, we are glad to see that the issuance of green bonds has an instant impact on the stock prices. Nevertheless, the higher stock prices do not sustain for a long period. It can be said with certainty that only issuing green bonds is not influential enough, other environmental performances, such as purchasing more pieces of environmentally friendly equipment, should also be carried out. Besides, had the government supported and encouraged green projects more, these public companies which issued green bonds could attract more investors and keep higher stock prices.

7. Conclusion

This paper shed light on the green bonds -- a relatively new fundraising tool and its short- term and long-term effects on corporate. Through initially collecting relevant information, we conclude that (1) green bonds have gained popularity since 2016, (2) issuance of green bonds attracts investors who prefer socially-responsible and environmental-friendly investment. (3) issuance of green bonds may have a positive effect on company's operating income.

We then study short-term effects of issuing green bonds on corporate and focus on the changes in stock prices. Setting the date of issuance as the discontinuity point, we reach the outcome that issuing green bonds have an instant but temporary positive impact on stock price. Such a phenomenon fit the findings proposed by Caroline Flammer in his paper Corporate Green Bonds, but reflect some weakness in the current situation. To sustain the higher stock prices, corporate need to employ more environmental-friendly tools, such as desulfurization equipment. Moreover, in the long-term effects, company can benefit from issuing green bonds according to the empirical analysis. Issuing green bonds not only brings economic benefits, but also contributes to social environmental protection. Both company and government ought to show more support and encourage these green projects. Once these green proposals are implemented, the effects of green bonds will be huge.

Acknowledgment

"Nanjing Audit University Student Innovation and Entrepreneurship Training Program Grant"

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