Are Green Bonds Valuable to Institutional Investors?*

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Abstract

Institutional investors are facing increasing pressure to improve the ESG profile of their investment portfolios. With these recent developments, green bonds are likely to become an integral part of their bond portfolios in the future. With this in mind, we construct the most comprehensive and up-to-date dataset of green bonds issued around the world. We then utilize this dataset to examine the issuance and secondary market pricing characteristics of both the international and the Korean markets for green bonds. We document the existence of a sizeable discount among Korean green bonds even after controlling for issuer and bond characteristics, suggesting that green bond investment in Korea needs not imply a sacrifice in terms of expected returns. However, during the COVID-19 outbreak, these bonds encounter deeper price discounts relative to their peers, emphasizing the need to carefully monitor these assets during periods of market crisis.

JEL classification: G12; G14; G23.

Keywords: ESG investment; socially responsible investment; green bonds; institutional investors; COVID-19.

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1. Introduction

Institutional investors in Korea face increasing pressure to incorporate a firm's environmental, social, and governance (ESG) profiles into their investment decisions. For example, the National Pension Service (NPS) of Korea, with more than $600 billion in assets under management as of 2019, are currently taking steps to establish systematic ESG investment processes across their traditional asset classes.[1] Specifically, in addition to the existing set of ESG investments already in place as a part of their active domestic equity strategy, the NPS investment management committee has voted to expand similar approaches to fixed income assets and plans to implement such ESG investment processes by 2022. With the NPS taking the lead in ESG investment in bond markets, other Korean institutional investors with substantial bond holdings including the National Housing and Urban Fund are expected to follow suit. These plans will therefore be a catalyst for fundamental changes in the Korean bond market landscape in the years to come.

These changes to institutional investor preference are happening *pari passu* with an explosive growth of the market for "green bonds," namely fixed income instruments whose proceeds are designated specifically for environment-friendly projects. With the first green bond launched in 2007 by the World Bank, the market has grown at an unprecedented pace, and as of 2019, there are more than $250 billion green bonds in outstanding, with diverse issuers including supranational organizations, local and national governments, and corporations. With many institutional investors now increasingly evaluating the ESG profiles of their bond holdings,[2] green bonds have a natural appeal to them, and these bonds are expected to form an increasingly integral part of investors' bond portfolios.

This changing financial landscape necessitates an in-depth analysis of the green bond market and investment implications for the institutional investors. Above all, the question of whether the ESG investment generates value for these investors is crucial. The NPS Investment Management Committee, for example, has

[1] For more information, refer to "Strategies to Promote the NPS Investment Management's Responsible Investment" released by the NPS Investment Management Committee (Item 2019-17) on Nov. 29, 2019.

[2] Hartzmark and Sussman (2019) document the existence of similar nonpecuniary motives among U.S. mutual fund investors using the release of Morningstar sustainability ratings as a causal shock.

clearly stated when releasing their Item 2019-17 in November 2019 that it is important to determine whether ESG investments would enhance the NPS's long-term return profile when voting on these ESG investment proposals. On the one hand, ESG-motivated investments can lead to lower returns because of investor demand from these investors who are willing to forgo financial gains for ESG purposes.[3] On the other hand, incorporating ESG risks into investment decisions can improve investors' risk-return profile (Krueger, Sautner, and Starks, 2020) as they can work as a hedge against disastrous events. As such, examining the risk and return profiles of green bonds in the Korean market and its implications for ESG-motivated investors is an important, open empirical question that has not yet been studied in the literature. For major Korean institutional investors with a dominant position in fixed income securities,[4] the lack of such academic discussion on green bonds limits their ability to implement ESG strategies in the domestic bond market as they see fit.

This paper intends to fill the void in the literature by providing the first study on the Korean green bond market vis-à-vis the international green bond market and examining the pricing implications for institutional investors, both in normal periods as well as in times of severe market stress such as the COVID-19 pandemic. To this end, we construct a comprehensive dataset, starting from all international green bond issuances reported in Bloomberg. While a number of recent studies similarly examine the market for green bonds (e.g., Hachenberg and Schiereck, 2018; Baker, Bergstresser, Serafeim, and Wurgler, 2019; Kapraun and Scheins, 2019; Zerbib, 2019; Flammer, 2020; Larcker and Watts, 2020; Tang and Zhang, 2020), most of them examine only a small subset of the green bond universe. For example, most of the empirical analyses in Baker, Bergstresser, Serafeim, and Wurgler (2019) and Larcker and Watts (2020) are conducted using green bonds issued by U.S. municipalities. Thus, it is not straightforward to understand the comprehensive picture of the overall market for green bonds, let alone how the Korean green bond market fares relative to the rest of the world on the basis of these existing studies. In contrast, our dataset is the most comprehensive dataset of the green bond market, allowing us a more detailed examination of Korean green bonds.

[3] The survey of U.S. mutual fund investors documented in Riedl and Smeets' (2017) show that many investors prefer to hold ESG-friendly investments despite their potentially lower returns.

[4] For example, MMFs and domestic fixed income securities constitute over 75% of the Korean Investment Pool for Public Funds, the primary means of asset management for most small-to-medium-sized Korean public agency funds.

We first document the issuance characteristics of green bonds as of June 2020. Among our sample green bonds across the world, we find that over 60% of these bonds hold an investment grade rating, while the comparable figure for high-yield-rated green bonds is under 5%, with the remaining one-third of green bonds not rated. Thus, the dominant majority of green bonds are likely to satisfy the investment mandates of institutional investors that usually include minimum credit rating requirements of investment grade. The top four sectors of green bond issuance are financials, government, utilities, and energy, respectively. These four sectors together account for close to 90% of all green bond issuances, suggesting that the market for green bonds has yet to see issuances across a diverse set of industries, a potential cause for concern among institutional investors hoping to achieve industry diversification in their bond portfolios.

Over a half of green bonds in our sample are issued by municipal governments, with asset-backed securities comprising another quarter of the sample. In contrast, bonds issued by corporations and financial firms account for less than 15% of total green bond issuances. In terms of country breakdown, U.S. issuers account for just under 80% of all green bond issuances, while European Union countries account for around 8% of the issuances. With 41 green bond issuances, Korea accounts for around 0.3% of the total issuances. Thus, the market for green bonds, on the whole, continues to be dominated by the U.S. market, while the Korean market only accounts for a small fraction. As for the time series patterns, we document a year-on-year increase in the number of green bond issuances for every year from 2013 to 2019, with the annual number of green bond issuances increasing from 196 in 2013 to 3,716 by 2019, nearly a twenty-fold increase.

Out of the 41 green bonds issued by Korean issuers, 29 are issued by corporate or financial issuers, with the other 12 issued by government agencies or the government itself. With the first green bond issued in 2013, we find that the number of issuances gradually increases from 2016 onwards, with 25 issuances in 2019 alone. The overall time series pattern suggests that, both in the world and in Korea, the expansion of the market for green bonds is a very recent phenomenon, with the bulk of issuances taking place within the past few years, further necessitating the need to examine this market in closer detail.

We then proceed to examine the secondary market prices of these bonds. Specifically, we compare the yields to maturity of green bonds against those of other non-green (or "brown") bonds issued by the same

issuer. By comparing the yield to maturity (YTM) of green vs. non-green bonds of these same issuers, we by-pass many potential complications regarding whether the pricing differential emanates from inherent differences in issuer characteristics (Choi, Hoseinzade, Shin, and Tehranian, 2020). For the international sample, we find that green bond yields are lower than those of non-green bonds until around 2015, suggesting that these bonds trade at a relative premium during the early period of our sample. The situation reverses post-2015 and green bonds trade at a discount for the remainder of our sample period. However, even though green bonds trade at a discount with higher YTM on average compared to non-green bonds, we document the existence of a statistically significant "greenium" once issuer and bond characteristics are accounted for, suggesting that there is indeed some degree of green bond premium in the secondary market.

For green bonds in the Korean market, however, we obtain a different picture. Green bonds always trade at a discount throughout our sample period, with higher YTM relative to non-green bonds, and this relationship remains statistically significant even after controlling for issuer and bond characteristics. The size of this discount is economically strong, with the YTM of green bonds around 0.8%p higher than their non-green peers. Thus, while we document some evidence of "greenium" in the international green bond market, the reverse appears to be true within the Korean bond market, with green bonds trading at a sizeable discount.

In the last part of our analysis, we examine how these Korean green bonds, which appear to provide investors with a higher yield, fare during a period of severe market stress. We focus on the crisis surrounding the COVID-19 outbreak, with the difference-in-difference setting around the WHO's declaration of global pandemic. Lins, Servaes, and Tamayo (2017) document strong statistical evidence of firms scoring highly in their corporate social responsibility (CSR) outperform their peers during the global financial crisis, and Ding, Levine, Lin, and Xie (2020) confirm similar stock price patterns during the COVID-19 outbreak. In a similar vein, Pastor and Vorsatz (2020) document that funds with high Morningstar sustainability ratings experienced smaller outflows during the COVID-19 outbreak. Thus, for the equity side of the market, it appears that commitment to ESG activities acts as an "insurance" mechanism for the firms' stock price. However, we find that the opposite is true of green bonds. The average YTM of Korean green bonds relative to their non-green

peers widens over the COVID-19 pandemic, suggesting that green bonds are subject to a larger price fall during periods of market stress.

Our results hold important implications for institutional investors planning to incorporate ESG assessments in their bond investment. While the green bond does appear to provide an excellent means of implementing ESG-motivated investment in the bond market, our empirical analysis hints that there is sizeable "greenium" in the international bond market once issuer and bond characteristics are accounted for, suggesting that some sacrifice of expected returns may be unavoidable. However, as far as the Korean bond market is concerned, we document the existence of a "green bond discount," with substantial economic magnitude. This may be partially attributable to the relatively small number of green bond issuance within the Korean market as things stand. In any case, though, the current state of the Korean bond market enables institutional investors to implement ESG investments in the bond market while "reaching for yield" at the same time (Choi and Kronlund, 2018). Of course, it is certainly not a given that such discounts will remain significant going forward, particularly as the ESG-motivated institutional investor demand for such assets increase, but as things stand, there does not appear to be a clear trade-off in green bond investment and expected returns. However, our analysis of the COVID-19 outbreak suggests that the investor base for these green bonds may be more fragile compared to their non-green peers, and that it would be dangerous to assume that the resilient stock prices of firms with high ESG profile would be similarly observed in the bond market. This would be particularly painful for institutional investors whose purchases and sales often carry sizeable price impact. As the investment in such green bonds rises, our empirical results emphasize the need to monitor the changes in YTMs of these green bonds, particularly during times of a major market crisis.

In addition to the practical implications of our analysis for Korean institutional investors, our analysis also contributes to the fast-growing literature on green bonds (e.g., Baker, Bergstresser, Serafeim, and Wurgler, 2019; Flammer, 2020; Larcker and Watts, 2020; Tang and Zhang, 2020). By compiling an up-to-date, comprehensive dataset of green bonds across the world, we capture the recent trends in green bond issuances around the world as well as engage in a secondary market analysis of green bond yields during the COVID-19 outbreak. In doing so, we provide important insights on the nature of the "greenium" during times of market

stress. Our study is also the first to document both the issuance and secondary market characteristics of green bonds issued by Korean issuers, highlighting the existence of a "green bond discount" among Korean green bonds, in contrast with the rest of the world.

2. Data Sources

For an empirical investigation of international green bonds, we collect our sample green bonds and data on their terms and conditions from Bloomberg New Energy Finance (BNEF). New Energy Finance was originally founded in 2004 as a startup in London, as a subscription-based service providing data on energy investment and carbon markets. It was acquired by Bloomberg L.P. in 2009 and has become its subsidiary, renamed as Bloomberg NEF, or BNEF. It now provides information on the financial, economic, and policy implications of the new energy sector across six continents publishing more than 700 research reports annually. While there are other vendors such as Thomson Reuters Eikon, Dealogic, or Environmental Finance that also provide data on green bonds, BNEF provides the most comprehensive database on green bond issuance. As of June 2020, BNEF records 14,947 social debts, of which 14,184 are green bonds.

We begin by collecting the entire universe of green bonds from BNEF for the period ranging from 2007 to 2020. We obtain both issue- and issuer-specific information including bond CUSIP, issuer name, sector, industry, country, currency, and amount issued. We exclude ABS, municipal bonds, and project bonds in our main bond pricing analysis, because their pricing can be fundamentally different from corporate green bond issues. After this exclusion, our sample comprises 3,079 green bond issues.

Secondary market pricing data are drawn from the Bloomberg Terminal. We obtain bond pricing data for our sample green bonds and non-green bonds issued by the same firms, as our main empirical analysis employs the examination of within-firm price differentials. For each green bond in our sample, we extract issuer information from the Bloomberg Terminal using its CUSIP identifiers and obtain a list of non-green bonds of the same issuer. We are able to locate 109,985 bonds, of which 2,171 bonds are green bonds. We then retrieve daily data on mid yield to maturity (YLD_YTM_MID) and last price (PX_LAST) from the Bloomberg terminal

for the period from January 2010 to June 2020. Of the green bonds, 1,192 bonds have yield data available. The control group are 34,809 corresponding conventional bonds by the green bond issuers.

3. Main Results

In the first part of our empirical exercises we provide a documentation of market descriptive statistics of green bond issuance around the world, focusing on the comparison of the Korean and international green bond markets. In particular, we provide the overall market descriptions with respect to issuing countries and markets, issuer sectors, issue currencies, issuance years, and green bond ratings. For the Korean green bonds, we provide a documentation across specific issuers. The second part of our analyses provides the examination of green bond pricing relative to non-green bond pricing, namely, the existence of "greenium", or the price premium of green bonds. We examine time-series trends in the green bond premium compared with the brown bond counterpart both in the full sample and in Korean market. In the last part of our paper we examine green bond pricing during the COVID-19 crisis in March 2020 for Korean green bonds, which should shed light on the extent to which green investing can provides a hedge to conventional investing strategies under the market disaster episodes.

a. Overall Descriptive Statistics

To better understand the development of the Korean green bond market vis-à-vis the global green bond market, we begin by documenting the descriptive statistics of green bonds both in the full sample and in the subsample of Korean issuers. Table 1 illustrates the primary market characteristics of green bonds such as issue amounts, maturity, coupon, and other bond characteristics. Our sample consists of all green bond issuances whose information is available in the BNEF universe, excluding municipal, ABS, and project bonds.

Panel A Table 1 shows the summary statistics of the full sample, while Panel B shows the same statistics for the Korean sample. The average issuance size (issued amounts) is 0.28 Billion USD, with an inter-quartile range of 0.35 Billion USD. In comparison, we find that the average issue amounts in Korean green bonds tend to be smaller, at 0.26 billion USD on average. There is substantial cross-sectional variation in issue amounts in

the Korean market. Note that the number of green bond issues in Korea is quite low in our sample period, that is, there are a total of only 36 issues in our BNEF universe in comparison with 2,171 in the full sample.

Panel A also shows that the Korean green bonds tend to be much shorter maturities than the international green bonds in our sample. For example, the average maturity and median of the international green bonds are around 10 and 6 years, respectively, while those of the Korean green bonds are 5 and 5 years, respectively. Coupon rates for both samples are comparable, being 2.71 for the full sample and 2.15 for the Korean sample. Three quarters of green bonds for the international sample are bullet bonds, whereas all Korean green bonds in our sample are bullet bonds. There are no callable, perpetual, or secured green bonds in our sample of Korean green bonds, whereas the distribution of the characteristics is more diverse in the full sample.

Panels C and D summarize the Bloomberg composite credit ratings of our sample green bonds for the international and Korean green bonds, respectively. Vast majority of the bonds in all the samples are investment grade. Given that the holding criteria of most institutional investors are credit ratings in investment grade, most of these green bonds would satisfy the holding criteria.

b. Market Composition

In this subsection, we document the issuance characteristics of green bonds including the bond type, issuer, issuing country, issuing year, issuer sector, and bond industry. Table 3 provides the sample statistics for the global sample and Table 4 provides the statistics for the Korean sample.

Panel A of Table 3 counts international green bonds across bond types. Over half of the green bonds in our sample are municipal bonds, indicating the US local governments' preference to the environmentally friendly projects. The next major bond type is asset-backed security (ABS) at nearly a quarter of the sample, which are backed by environmentally friendly assets, which ensures that bond issuance proceeds are used for green projects. Next up are the financial institutions, corporates, and the supranational institutions. Government agencies, sovereign bonds, and project bonds (i.e., non-recourse bonds with the bond proceeds hypothecated for designated environmental-friendly projects) fill in the last void.

Panel B Table 3 provides the results from examining the sample at a country level, which shows the dominance of US-issued green bonds in the global sample. This is mainly driven by green bonds issued by US municipalities, which, again, make up for more than half of our sample. Panel B also shows country breakdowns, showing that South Korea documents 41 green bond issuance in this sample. It is worth mentioning that in the most updated sample as of October 2020, this number has grown to 95, showing the strong growth of the South Korean green bond market.

The next panel, Panel C, lists green bond issuance by year. We see an exponential growth in issuance, where within a decade the figure goes from one to four digits. Starting out with mere 6 bonds in year 2007, by 2019 the figure reaches to 3,716 bonds issued. Currency-wise, reported in Panel D, the majority of the green bonds are issued in USD, with Euros, Swedish Krona and Chinese Yuan following up. Panel E lists the bonds by issuer sectors. Financial firms are in the lead with 811 issuances, with governments and utilities following up with 561 and 390 issuances, respectively. Panel F is the count by industry. Banks and real estate firms are in the lead, with 363 and 304 green bond issuances respectively, with supranational institutions and power generation following up with 214 and 201 issuances, respectively.

Panel G shows the growth of each bond type throughout the years. In the earlier years, we see a dominance by the public sector, in municipal bonds and supranational bonds. As the market expands, we see other types of bond enter the market, such as corporations or FIGs (financial institutions groups). The recent years has seen a surge in ABS issuance, which is a good fit with green bonds as it is easier to avoid green washing when the bonds are backed by green assets.

Table 3 shows the counts of Korean green bonds across types. For the Korean green bonds, as shown in Panel A, most of the issuance bond type is by the corporations, making up for more than half of the sample. The leading issuers, in Panel B, are Hyundai Capital Services and Export-Import Bank of Korea, with other companies following suite with a few issuances. Shown in Panel C, Korea has taken some time in participating in the green bond market, with the first issuance in 2013. However, since its issuance, the figure has been doubling on an annual basis. Panel D illustrates the issuance by currencies. Most of the bonds are denominated in US Dollars or Korean Won, but there exists a few Swiss Francs, Euros, and Indian Rupees as well.

c. How are green bonds priced relative to their non-green counterparts?

Next, we examine the pricing of green bonds by comparing their yields with non-green bonds. The core puzzle in socially responsible investment literature is whether sustainable investing financial securities carry a price premium with them. The coined term for green bonds is the "greenium", or green premium. On one hand, the investor taste theory argues that investors are willing to pay a premium for an instrument with social benefits, and hence the greenium should be positive. On the other hand, because green bonds are a relatively newer instrument with a limited investor base, it can be argued that green bonds would need to compensate the investors with a higher yield. This indicates a negative greenium. A third group argues that because green bonds are not any different from an otherwise identical brown bonds, their yields should also be identical as well, hence no greenium should exist.

We examine whether the green bond yields carry a greenium, and if so, to what extent. We include all the bonds issued by the entities that have issued green bonds and look at the secondary market transactions yields to investigate whether the green bonds trade with different yields from non-green bonds. Figure 1 depicts this in a graphical manner. Plotting the yields to maturity of all the green bonds and brown bonds (i.e., non-green bonds) of the same issuers, we find that in the earlier part of the sample before 2015 green bonds on average have lower yields than brown bonds. Around 2015, however, this relationship reverses, and green bonds begin to trade at lower price (i.e., their yields are higher). This result is partly consistent with the segmented market story whereby their investor demand is rather limited. This is also somewhat synchronous to the introduction of stricter requirements for green stamping, for example, the introduction of Green Bond Principles by the International Capital Market Association or Green Financial Bond Guidelines by the Chinese government. In such light, it is also consistent with green washing, that is, issuers simply label the financing of less environmentally friendly projects as green. The subsample of Korean green bonds is shown in Figure 2. The sample starts from 2016, and follows the post-standardized yield relationship as well, where green bonds trade at a slightly higher yield.

Next, we examine whether such a relationship holds after controlling for bond characteristics, issuers, or time, with regression analysis. To examine the relationship more clearly, we employ the following regression specification:

$$y_{it} = \beta_0 + \beta_1 G_i + \gamma_t + \delta_i + \epsilon_{it},$$

where Y is the mid yield to maturity, G is the dummy variable for whether the bond is self labelled as a green bond, γ_t captures time fixed effect, and δ_i captures time invariant, bond specific fixed effects. The coefficient of interest is β_1.

This is reported in Table 4. Panel A shows that green bonds carry price premium (i.e., lower yields) once we control for bond, issuer, and time fixed effects. Without controlling for such characteristics, however, we find that greens bonds appear to trade at discount, as we can see from Columns 1 through 3 where the positive coefficient estimates show indicate that green bonds carry higher yields than brown bonds of the same issuers. In Column (1), for example, green bonds carry 1.391% higher yields than brown bonds. After accounting for bond characteristics, time, and especially the issuer, we can see a significant green bond premium, or "greenium" of 16.3 basis points, as can be seen from Column (4).

In Panel B of Table, we find somewhat different results for Korean green bonds. We find consistently that green bonds carry higher yields (i.e., a green discount) throughout the specifications and even when we control for several types of fixed effects. In Column (4), for example, Korean green bond issues show a significantly high green bond yields even after accounting for these fixed effects, again statistically significant, at 82.8 basis points. We find that these results are puzzling and deserve further research in future studies.

d. In Times of Crises

The last piece of our study is to examine how green bonds fare during times of severe market distress, compared to conventional bonds. Most extant literature that study corporate goodness in bad times finds that "doing good" helps to "do well" on the equity side. Nonetheless, we have yet to study how bonds fare, and we document the opposite result.

We focus on daily Korean green bond yields in 2020 to examine the specific change in secondary market yield with the propagation of COVID-19. To examine this in depth, we run a difference-in-differences test with pandemic declaration by the WHO on March 11, 2020 as a shock date with the following specification:

$$y_{it} = \beta_0 + \beta_1 G_i + \beta_2 P_t + \beta_3 G_i P_t + \gamma_t + \delta_i + \epsilon_{ikt},$$

where Y is the mid yield to maturity, G is the dummy variable for whether the bond is a green bond, P is the dummy variable indicating whether the yield date is post pandemic declaration, γ_t captures time fixed effect, δ_i captures time invariant bond characteristics fixed effects. The coefficient of interest is β_3. In tests with time fixed effects, $\beta_2 P_{it}$ is dropped due to multicollinearity.

Figure 3 and Table 5 document such results. We focus on daily bond yields of 2020, especially around the initial propagation of the COVID-19 outbreak. The recession triggered by the COVID-19 pandemic is one of the worst economically destructive crisis of the century, causing crashes not only in the stock market but also in the real economy as well. COVID-19 is very much an ongoing concern, thus there is no perfect clear-cut measure of its shock. For this analysis, we use the date when the WHO issued the pandemic declaration, namely March 11, 2020, which reflects the date when the novel coronavirus came to be recognized as a real shock across the world. Figure 3 reveals that, in the post-pandemic declaration period, the Korean bond market has witnessed an increase in green bond yields relative to brown bonds at about 15 bps.

The regression analysis gives us a consistent picture. After considering the bond characteristics, issuers, and the date, such a relationship persists. Regardless of whether we use the raw regression, or whether we include different fixed effects, the interaction term between the green bond dummy and the post COVID-19 pandemic declaration dummy is consistently positive at around 15bps, ranging from 16.9 bps in column (1) to 14 bps in column (3). This suggests that during the shock, green bonds suffer a significant price fall, even more so than their brown counterparts.

It is worth emphasizing that such a yield behavior on the bond side of the market is different to that of the equity side. There are several papers that examine stock market reaction to corporate goodness during crises, such as Lins, Servaes, and Tamayo (2017) or Albuquerque, Koskinen, Yang, and Zhang (2020), who find that firms with a high degree of CSR activities outperform during the crises. However, this setting cannot

capture all the unobservable cross-sectional differences in firm characteristics and makes it difficult to determine whether the environmentally friendly firms outperformed during crises because they were different, or because they were better. Our results suggest that the opposite is true for bonds, and that when the issuer characteristics are appropriately controlled for, green bonds are susceptible to a larger price shock during crises periods than the conventional bonds of same firm.

4. Further Discussion: Do Green Bonds Hold Value for Korean Institutional Investors?

Korean public agency sponsors are facing increasing pressure to incorporate a firm's ESG profile into its investment decisions. All Korean public agency sponsors with assets under management over KRW 1 trillion ($900 million) are subject to an annual performance evaluation of the quantitative and qualitative aspects of their asset management conducted by the Ministry of Economics and Finance, with other smaller sponsors evaluated every two years. From the performance evaluation for the fiscal year 2018 onward, the Ministry of Economics and Finance added the following criteria into the quantitative performance evaluation, namely: "How much of the sponsors' assets are being invested to meet the broader public interests?" The assets satisfying the definition of this "broader public interests" are as follows: funds used to subsidize debt financing of small-to-medium enterprises (SMEs), policy funds to promote corporate growth of startups and SMEs in the "new engines of economic growth" area designated by the government, and most importantly, SRI funds. The incentive on ESG-motivated investment for Korean public agency sponsors has thus become heightened in recent years.

However, fixed income securities remain the predominant means of investment for Korean public agency sponsors. The NPS, for example, holds 42.0% and another 4.9% of its assets in domestic and foreign bonds as of July 2020, respectively; the combined figure of bond investments is larger than that of equity investments. Similarly, the Government Employees' Pension holds 42.2% of its assets in bonds as of year-end 2019, substantially higher than the comparable figure for equities at 31.5%. For public agencies that provide financial guarantees such as the Korean Credit Guarantee Fund, the figure is substantially higher, with over 90% of the assets containing primarily fixed income exposure. This is further reflected in the fact that the Korean

Investment Pool for Public Funds, which is the primary means of investment for smaller public agency sponsors, has 70% of its assets in fixed income instruments, with another quarter of the assets in balanced mandates with substantial fixed income exposure.

Thus, for these Korean sponsors, the increasing pressure to incorporate ESG profiles into investment decisions is likely to be reflected primarily through their investment in the bond market, and green bonds are likely to form a predominant part of their portfolios in the years to come. Moreover, the domestic green bond market is likely to become ever more important, as these sponsors tend to hold the majority of their fixed income position in the domestic market; as discussed earlier, the NPS' share of domestic bond investment is over eight times that of its foreign bond investment. This raises a natural question regarding whether green bond investment in the Korean bond market represents a valuable investment opportunity for these institutional investors; after all, the presence of a significant "greenium" in the secondary market, for example, would lower the expected returns on these ESG-motivated investments. While the main rationale behind ESG investment in the bond market needs not emanate from pecuniary motives only, it is nevertheless important to ascertain whether investing in such markets represents a fundamental change to the sponsors' risk-return profile.

Our results indicate that, once issuer and bond characteristics are accounted for, there is a statistically significant "greenium" in the international market for green bonds. Our estimates indicate that, while green bonds appear to be trading at a discount, most of this is attributable to issuer characteristics, and green bonds trade at a premium of around 16 bps relative to the issuers' non-green bonds once these characteristics are controlled for. In this respect, when investing in the foreign market for green bonds, some sacrifice of expected returns appears to be unavoidable; with many institutional investors actively increasing their ESG investments, it is not surprising that green bonds are trading at a premium. However, we obtain a very different picture for Korean green bonds. Ever since the first issuance of green bonds in 2013, we document the existence of a sizeable green bond discount in the Korean bond market throughout our sample period. This may be attributable to the fact that the discussion on ESG investment in Korea, until recently, has focused mainly on equities, with relatively little attention given to the bond market, suggesting that the demand for these assets is yet to be fully expanded. Given that a sizeable discount exists relative to the non-green bonds of similar maturity

and option feature characteristics issued by the same issuer, this represents a clear opportunity to "reach for yield" with a higher expected return. Of course, as many large-sized sponsors increase their ESG-motivated investments, this picture is likely to change in the future, but as thing stand, this offers a valuable opportunity from institutional investors' perspective.

However, the secondary market pricing of Korean green bonds during COVID-19 suggests that these securities are more susceptible to a large price fall during periods of severe market stress. This is in contrast with the existing literature on the stock price implications of CSR activities, which finds a firm's CSR activities to be an insurance mechanism that provides the firm with a price cushion during such crisis periods. Thus, while the Korean green bonds represent a valuable opportunity to "reach for yield" with additional expected returns, these securities also appear to have greater potential for price crash during a market stress period. This necessitates a careful monitoring of the performance of green bonds during a crisis period in terms of risk management perspective. At the same time, however, the trough of the crisis may, at the same time, provide an excellent investment opportunity to improve the investment portfolio's ESG profile while taking full advantage of the depressed price, suggesting that a more detailed and careful analysis of the market may unlock sizeable performance potential for the sponsors' bond investment.

5. Conclusion

In this paper, we compile a comprehensive dataset of all green bond issuances identified in Bloomberg to analyze the issuance and secondary market characteristics of these bonds. Our dataset is the most up-to-date and comprehensive dataset that captures both cross-sectional and time series trends of this fast-growing market segment. With many Korean institutional investors facing increasing pressure to improve their ESG investment, not just in their equity portfolio but also their bond portfolio, it is apt and timely to examine the market for green bonds in greater detail, which is likely to form an integral part of these institutional investors' bond investments in the future.

Our empirical analysis yields a number of interesting features of this market. Although green bonds are being issued by many issuers, in terms of both issuer entity, sector, and geographic regions, the market does

not appear to be fully diversified, with U.S. municipalities accounting for the largest number of green bond issuances and the issuances concentrated in a handful of industries. In terms of time series trends, the number of green bonds issuances is increasing year on year for every year since 2013 until 2019. Above all, we document the existence of a sizeable green bond premium in the international bond market relative to comparable non-green bonds with similar characteristics issued by the same issuer. In contrast, for the Korean market, we obtain a significant green bond discount, suggesting that these domestic green bond investments may provide the institutional investors with a valuable opportunity to "reach for yield" and increase its ESG profile without sacrificing the expected returns. However, these green bonds also appear to be subject to greater price falls during periods of market stress such as COVID-19, emphasizing the need for careful monitoring of these assets' pricing in crisis periods.

With the annual number of worldwide green bond issuances increasing eightfold in the space of six years, we highlight that this is a fast-changing and continuously evolving market segment. In particular, as the Korean public sponsors' preferences change, the pricing and issuance of green bonds in Korean bond market is also likely to be significantly affected. From the institutional investors' perspective, our findings highlight the need to engage in careful and continued monitoring of this growing market; with many green bonds trading currently at a discount, a further analysis into what this discount means and whether it truly represents a valuable investment opportunity would enhance the investors' long-term risk-return profile.

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Figure 1: YTMs of Green Bonds and Brown Bonds in the International Bond Market

This figure plots monthly average yield to maturity of green bonds and their issuers' brown bonds. The red line denotes average green bond yield, the blue line denotes the average conventional bond yield, and the green line denotes the difference thereof, or "greenium". The yields are winsorized at 1%. Time span is from June 2012 to June 2020.

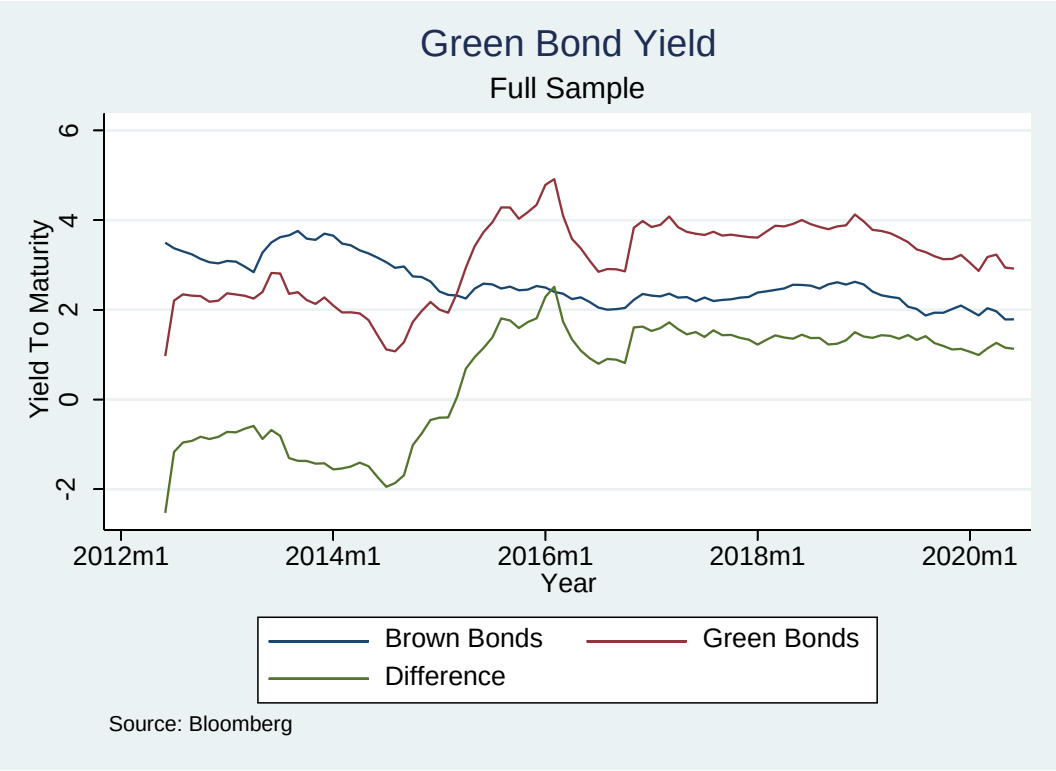

Figure 2: YTMs of Green Bonds and Brown Bonds in the Korean Bond Market

This figure plots monthly average yield to maturity of Korean green bonds and their issuers' brown bonds. The red line denotes average green bond yield, the blue line denotes the average conventional bond yield, and the green line denotes the difference thereof, or "greenium". The yields are winsorized at 1%. Time span is from February 2016 to June 2020.

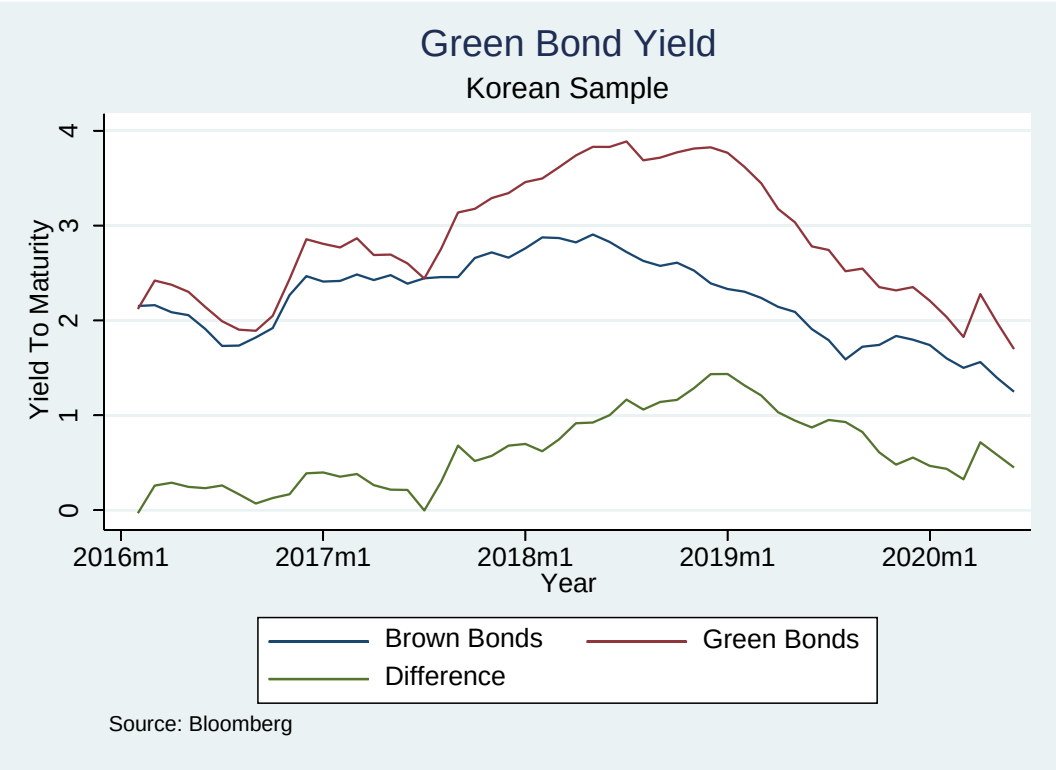

Figure 3: YTMs of Korean Green Bonds and Brown Bonds around the COVID-19 Pandemic

This figure plots daily average yield to maturity of green bonds and their issuers' brown bonds in year 2020. The red line denotes average green bond yield, the blue line denotes the average conventional bond yield, and the green line denotes the difference thereof, or "greenium". The red vertical line denotes the WHO pandemic declaration date of 11 March 2020. The yields are winsorized at 1%. Time span is from January 2020 to June 2020.

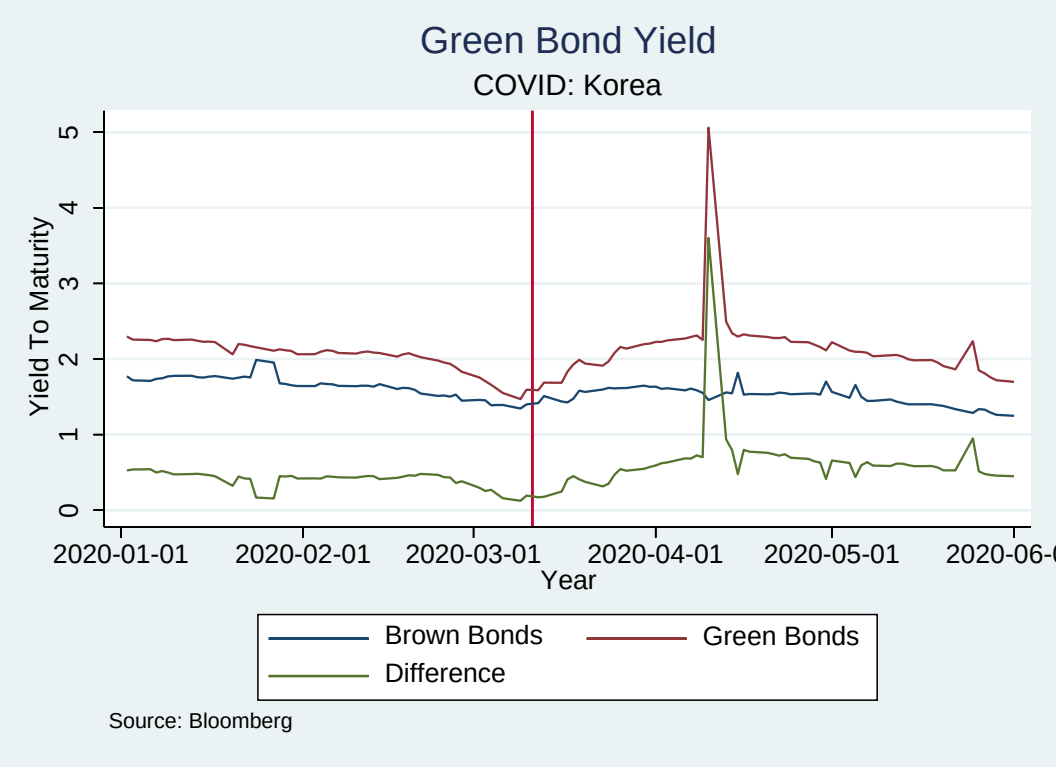

Table 1. Summary Statistics

This table states the bond level summary statistics of green bond issuances. ABS, municipal bonds, and project bonds are excluded due to their difference in nature. Panel A shows the green bond summary statistics of the full sample. Panel B shows the summary statistics of the Korean-issued green bond sample. Panel C and D show the ratings of the green bonds, full sample and Korean, respectively.

Panel A: Full Sample

	Mean	St. Dev.	# nobs	Q1	Median	Q3
Amount Issued (In Billions USD)	0.28	0.47	2,146	0.04	0.1	0.37
Maturity at Issue (Years)	9.54	31.17	2,143	5	6	10
Coupon	2.71	2.32	2,157	0.85	2	4.2
Bullet	0.75	0.43	2,171	1	1	1
Callable	0.19	0.39	2,171	0	0	1
Perpetual	0.01	0.11	2,171	0	0	0
Secured	0.14	0.35	2,171	0	0	0

Panel B: Korean Sample

	Mean	St. Dev.	# nobs	Q1	Median	Q3
Amount Issued (In Billions USD)	0.26	0.21	36	0.06	0.23	0.45
Maturity at Issue (Years)	4.97	2.16	36	3	5	5
Coupon	2.15	1.19	36	1.72	1.96	2.55
Bullet	1	0	36	1	1	1
Callable	0	0	36	0	0	0
Perpetual	0	0	36	0	0	0
Secured	0	0	36	0	0	0

Panel C: Green Bond Issuances by Rating, Full Sample

	# nobs	Percent
AAA	183	17.91
AA+	20	1.96
AA	31	3.03
AA-	38	3.72
A+	45	4.4
A	70	6.85
A-	71	6.95
BBB+	89	8.71
BBB	42	4.11
BBB-	45	4.4
BB+	10	0.98
BB	12	1.17
BB-	8	0.78
B+	3	0.29
B	5	0.49
B-	7	0.68
CCC-	1	0.1
CC+	1	0.1
DD+	1	0.1
NR	340	33.27
Total	1,022	100

Panel D: Green Bond Issuances by Rating, Korean Sample

	# nobs	Percent
AA	2	10
AA-	7	35
A+	1	5
BBB+	4	20
NR	6	30
Total	20	100

Table 2. Green Bond Characteristics Count: Full Sample

This table shows all green bond issuance characteristics as of June 2020, by bond type, country, year, currency, sector, and industry.

Panel A: By Type

	# nobs	Percent
ABS	3,460	24.39
Corporates	971	6.85
Financials	1,027	7.24
Government Agencies	358	2.52
Municipal	7,449	52.52
Project	196	1.38
Sovereigns	43	0.3
Supranationals	680	4.79
Total	14,184	100

Panel B: By Country

	Freq.	Percent
Argentina	5	0.04
Australia	57	0.4
Austria	11	0.08
Belgium	9	0.06
Brazil	135	0.95
Canada	61	0.43
Cayman Islands	36	0.25
Chile	11	0.08
China	363	2.56
Colombia	2	0.01
Croatia	1	0.01
Czech	3	0.02
Denmark	27	0.19
England	52	0.37
Estonia	1	0.01
Fiji	8	0.06
Finland	15	0.11
France	277	1.95
Germany	115	0.81
Greece	5	0.04
Hong Kong	40	0.28
India	45	0.32
Indonesia	6	0.04
Ireland	3	0.02
Israel	1	0.01
Italy	34	0.24
Japan	120	0.85

Latvia	3	0.02
Lithuania	5	0.04
Luxembourg	12	0.08
Malaysia	117	0.83
Mauritius	1	0.01
Mexico	14	0.1
Morocco	2	0.01
Netherlands	88	0.62
New Zealand	10	0.07
Nigeria	2	0.01
Norway	81	0.57
Peru	4	0.03
Philippines	8	0.06
Poland	8	0.06
Portugal	6	0.04
Russia	2	0.01
Singapore	12	0.08
Slovakia	1	0.01
Slovenia	1	0.01
South Africa	6	0.04
South Korea	41	0.29
Spain	54	0.38
Supranational	674	4.75
Sweden	385	2.72
Switzerland	24	0.17
Taiwan	28	0.2
Thailand	12	0.08
Turkey	1	0.01
United Arab Emirates	5	0.04
United States	11,128	78.48
Uruguay	1	0.01
Total	14,179	100

Panel C: By Year

	# nobs	Percent
2007	6	0.04
2008	10	0.07
2009	16	0.11
2010	389	2.74
2011	255	1.8
2012	232	1.64
2013	196	1.38
2014	490	3.45
2015	1,136	8.01
2016	1,402	9.88
2017	2,991	21.09
2018	2,717	19.16
2019	3,716	26.2
2020	628	4.43
Total	14,184	100

Panel D: By Currency

	# nobs	Percent
AUD	128	0.9
BRL	197	1.39
CAD	59	0.42
CHF	24	0.17
CNY	302	2.13
COP	11	0.08
CZK	2	0.01
DKK	8	0.06
EUR	615	4.34
FJD	8	0.06
GBP	62	0.44
HKD	33	0.23
HUF	10	0.07
IDR	29	0.2
INR	84	0.59
JPY	120	0.85
KES	4	0.03
KRW	16	0.11
MXN	29	0.2
MYR	121	0.85
NAD	1	0.01
NGN	2	0.01
NOK	71	0.5

NZD	26	0.18
PEN	2	0.01
PHP	4	0.03
PLN	7	0.05
RUB	14	0.1
SEK	497	3.5
SGD	2	0.01
THB	12	0.08
TRY	47	0.33
TWD	33	0.23
USD	11,551	81.44
Unknown	1	0.01
ZAR	52	0.37
Total	14,184	100

Panel E: By Sector

	# nobs	Percent
Communications	5	0.23
Consumer Discretionary	57	2.63
Consumer Staples	11	0.51
Energy	188	8.66
Financials	811	37.36
Government	561	25.84
Health Care	4	0.18
Industrials	95	4.38
Materials	37	1.7
Technology	12	0.55
Utilities	390	17.96
Total	2,171	100

Panel F: By Industry

	# nobs	Percent
Airlines	1	0.05
Apparel & Textile Products	2	0.09
Automobiles Manufacturing	15	0.69
Banks	363	16.72
Chemicals	7	0.32
Commercial Finance	29	1.34
Communications Equipment	4	0.18
Construction Materials Manufacturing	2	0.09
Consumer Finance	43	1.98
Consumer Products	1	0.05
Consumer Services	1	0.05

Containers & Packaging	4	0.18
Department Stores	1	0.05
Diversified Banks	33	1.52
Educational Services	1	0.05
Electrical Equipment Manufacturing	5	0.23
Financial Services	31	1.43
Food & Beverage	5	0.23
Forest & Paper Products Manufacturing	20	0.92
Government Agencies	121	5.57
Government Development Banks	85	3.92
Government Local	68	3.13
Government Regional	61	2.81
Hardware	4	0.18
Health Care Facilities & Services	2	0.09
Home Improvement	3	0.14
Industrial Other	43	1.98
Integrated Oils	1	0.05
Life Insurance	8	0.37
Machinery Manufacturing	1	0.05
Managed Care	1	0.05
Manufactured Goods	2	0.09
Medical Equipment & Devices Manufacturing	1	0.05
Metals & Mining	4	0.18
Power Generation	201	9.26
Railroad	2	0.09
Real Estate	304	14
Refining & Marketing	8	0.37
Renewable Energy	179	8.25
Retail - Consumer Discretionary	1	0.05
Retail - Consumer Staples	1	0.05
Semiconductors	2	0.09
Software & Services	2	0.09
Sovereigns	12	0.55
Supermarkets & Pharmacies	4	0.18
Supranationals	214	9.86
Transportation & Logistics	25	1.15
Travel & Lodging	32	1.47
Utilities	189	8.71
Waste & Environment Services & Equipment	17	0.78
Wireless Telecommunications Services	3	0.14
Wireline Telecommunications Services	2	0.09
Total	2,171	100

Panel G: Bond Types by Year

Year	ABS	Corporation	Financial	Government	Municipal	Project	Sovereign	Supranational	Total
2007	0	0	0	0	2	3	0	1	6
2008	0	6	0	1	1	1	0	2	11
2009	0	9	0	0	0	2	0	6	17
2010	0	0	0	5	305	5	0	75	390
2011	0	0	0	8	196	8	0	44	256
2012	0	1	0	3	190	12	0	32	238
2013	6	3	12	6	116	27	0	28	198
2014	20	31	44	22	288	27	0	66	498
2015	21	161	48	41	772	22	0	81	1,146
2016	91	80	88	50	1,011	21	1	87	1,429
2017	1,067	201	176	89	1,406	33	7	77	3,056
2018	1,147	238	279	95	968	25	12	89	2,853
2019	1,055	514	439	151	1,808	10	15	128	4,120
2020	53	94	100	48	386	0	10	38	729
Total	3,460	1,338	1,186	519	7,449	196	45	754	14,947

Table 3. Green Bond Characteristics Count: Korean Sample

This table shows Korean green bond issuance characteristics as of June 2020, by bond type, issuer, year, and currency.

Panel A: By Type

	# nobs	Percent
Corporates	24	58.54
Financials	5	12.2
Government Agencies	11	26.83
Sovereigns	1	2.44
Total	41	100

Panel B: By Issuer

	#nobs	Percent
Export-Import Bank of Korea	6	14.63
GS Caltex Corp	2	4.88
Hanjin International Corp	1	2.44
Hanwha Energy USA Holdings Corp	1	2.44
Hyundai Capital Services Inc	8	19.51
KB Capital Co Ltd	2	4.88
Korea Development Bank/The	3	7.32
Korea Electric Power Corp	1	2.44
Korea Hydro & Nuclear Power Co Ltd	1	2.44
Korea International Bond	1	2.44
Korea Midland Power Co Ltd	1	2.44
Korea South-East Power Co Ltd	1	2.44
Korea Water Resources Corp	1	2.44
LG Chem Ltd	3	7.32
LG Display Co Ltd	1	2.44
LOTTE Property & Development Co Ltd	1	2.44
SK Energy Co Ltd	4	9.76
Shinhan Bank Co Ltd	2	4.88
Wave Electronics Co Ltd	1	2.44
Total	41	100

Panel C: By Year

	# nobs	Percent
2013	1	2.44
2016	2	4.88
2017	4	9.76
2018	8	19.51
2019	25	60.98
2020	1	2.44
Total	41	100

Panel D: By Currency

	# nobs	Percent
CHF	1	2.44
EUR	3	7.32
INR	2	4.88
KRW	16	39.02
USD	19	46.34
Total	41	100

Table 4. Examining the Greenium

This table reports OLS regression of whether green bonds trade at a different yield than conventional bonds. (1) reports the raw regression, (2) adds the bond characteristics fixed effects, (3) adds the day fixed effects, and (4) adds the issuer fixed effects. Panel A reports regression with full sample, whereas Panel B reports the regression with Korean sample. Bond characteristics fixed effect includes option features such as callability or putability, bullet provision, credit rating, seniority, and option structure. We report White's heteroscedasticity-consistent standard errors. * denotes statistical significance at the 10% level, ** at the 5% level, and *** at the 1% level, respectively.

Panel A: Full Sample

	(1)	(2)	(3)	(4)
Green Bond Dummy	1.391*** (161.015)	1.023*** (124.190)	1.111*** (134.302)	-0.163*** (-56.405)
No. of Observations	25,546,978	25,032,916	25,032,916	25,032,916
Adjusted R-squared	0.002	0.097	0.103	0.163
Bond Characteristics FE	No	Yes	Yes	Yes
Issuer FE	No	No	No	Yes
Time FE	No	No	Yes	Yes

Panel B: Korean Sample

	(1)	(2)	(3)	(4)
Green Bond Dummy	0.673*** (32.979)	0.715*** (45.614)	0.867*** (56.589)	0.828*** (55.529)
No. of Observations	1,575,900	1,575,900	1,575,900	1,575,900
Adjusted R-squared	0.002	0.172	0.361	0.400
Bond Characteristics FE	No	Yes	Yes	Yes
Issuer FE	No	No	No	Yes
Time FE	No	No	Yes	Yes

Table 5. Korean Green Bonds during the COVID-19

This table reports OLS regression of whether green bonds trade at a different yield than conventional bonds during COVID-19 pandemic in Korea during 2020. (1) reports the raw regression, (2) adds the bond characteristics fixed effects, (3) adds the day fixed effects, and (4) adds the issuer fixed effects. Bond characteristics fixed effect includes option features such as callability or putability, bullet provision, credit rating, seniority, and option structure. We report White's heteroscedasticity-consistent standard errors. * denotes statistical significance at the 10% level, ** at the 5% level, and *** at the 1% level, respectively.

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	(1)	(2)	(3)	(4)
Green Bond Dummy × Post-COVID-19 Dummy	0.169** (2.332)	0.142** (2.539)	0.140** (2.539)	0.150*** (2.852)
Green Bond Dummy	0.461*** (8.455)	0.551*** (13.342)	0.540*** (13.379)	0.491*** (12.463)
Post-COVID-19 Dummy	-0.118*** (-39.550)	-0.096*** (-38.345)		
No. of Observations	228,823	228,823	228,823	228,823
Adjusted R-squared	0.010	0.301	0.328	0.403
Bond Characteristics FE	No	Yes	Yes	Yes
Issuer FE	No	No	No	Yes
Time FE	No	No	Yes	Yes