THE EFFECT OF CERTIFICATION ON GREEN BOND RETURNS

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ABSTRACT

THE EFFECT OF CERTIFICATION ON GREEN BOND RETURNS

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This thesis compares the daily secondary market total returns of green and brown bonds issued by the same issuers. Evidence suggests that investors have an incentive to invest in green bonds and this demand is reflected in green bond returns. When the return comparison is done based on whether the green bond is certified by the Climate Bonds Initiative (CBI), contrary to expectations, it is not possible to show any significant effect of this certification on the yield differential. The study also compares green and brown bond returns based on whether the bond's issuer has an ESG rating. Results indicate that the presence of an issuer ESG rating increases both green and brown bond returns. However, ESG presence does not make any additional contribution to the greenium. Lastly, by breaking down ESG presence into ESG Scores and Environmental Pillar Scores, a within-sample comparison of green and brown bond returns is performed on a before- and after-pandemic basis. Findings show that following the start of the pandemic, green bond returns have increased, implying a stronger demand for green bonds. Also, higher ESG Scores and Environmental Pillar Scores significantly increased returns of green and brown bonds after the pandemic.

Keywords: Green Bonds, Certification, ESG, Sustainable Finance, Pandemic

ÖZ

SERTİFİKASYONUN YEŞİL TAHVİL GETİRİLERİ ÜZERİNDEKİ ETKİSİ

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Bu tez aynı şirketler tarafından piyasaya sürülen yeşil ve geleneksel tahvillerin ikincil piyasa günlük toplam getirilerini karşılaştırmaktadır. Sonuçlar yatırımcıların yeşil tahvillere talep gösterdiğini ve talebin günlük tahvil getirilerine yansıdığını göstermektedir. Beklenenin aksine CBI sertifikası yeşil tahvillerin getirileri üzerinde anlamlı bir etki yaratmamaktadır. Bu çalışmada ayrıca şirketlerin halka açık ESG puanlarına sahip olmasının yeşil ve geleneksel tahviller üzerindeki etkisi incelenmiştir. ESG puanları hem geleneksel hem de yeşil tahvil getirilerini arttırırken, yeşil tahvillerin getirilerine ayrıca bir etki yaratmıyor. ESG varlığının etkisine ek olarak, ESG puanlarının ve çevre puanlarının yüksekliğinin yeşil ve geleneksel tahvil getirilerine olan etkisi araştırıldı. Analiz sonuçlarına göre bu puanların yeşil tahvil getirileri üzerinde anlamlı bir etkiye sahip olmadığı tespit edildi. Pandeminin başlamasıyla birlikte yeşil tahvil getirileri artarken, yüksek çevre puanına sahip şirketlerin geleneksel ve yeşil tahvilleri daha çok getiri sağladı.

Anahtar Kelimeler: Yeşil Tahviller, Sertifikasyon, ESG, Sürdürülebilir Finans, Pandemi

For my fur baby Tarçın,

Being your mother was the greatest honor of my life.

ACKNOWLEDGMENTS

Wow, I don’t know where to start. It is 5 am in the morning and I haven’t slept for almost 20 hours. This sentence quite summarizes the last few months of my life.

First of all, I would like to express my deepest gratitude to my advisor Assoc. Prof. Dr. Seza Danışoğlu. Without her guidance this thesis wouldn’t be possible. Even when I did not believe in myself, she never stopped believing in me. She is not my thesis advisor, but my academic parent.

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My dear best friend Batuhan, no day passes by I don’t think of you. I miss you so much. You were the most special person I have ever met. I will forever cherish our memories together and you will keep living in me. My Tarçik, when you came into my life I was falling into a space of endless darkness. You brought me back to life, you became my family, you taught me how to love without fear. I am so grateful that our paths had crossed. I will always be proud to call myself your mother.

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LIST OF ABBREVIATIONS

ICMA	International Capital Market Association
CBI	Climate Bonds Initiative
ESG	Environmental, Social, and Governance
EIB	European Investment Bank
WHO	World Health Organization
EPS	Environmental Pillar Score
TR	Thomson Reuters
GBP	Green Bond Principles
ISIN	International Securities Identification Number
SRI	Socially Responsible Investing
CSR	Corporate Social Responsibility

CHAPTER 1

INTRODUCTION

Since the dawn of time, the relationship between humankind and nature has been complex. Once seeing themselves as part of nature, now humans started considering themselves superior to all living beings. Without hesitation, they have exploited the planet. However, the fate of humankind is intertwined with nature. Climate change is not a myth anymore. As the frequency of catastrophic floods, forest fires, extreme weather conditions, and droughts is increasing worldwide, people's perception of nature has been evolving. Instead of scrolling on social media to see uncanny images of disasters, people are starting to take action to save the planet. At this point, sustainable finance links the bridge between financial markets and sustainability. Sustainable finance practices merge traditional investments and philanthropic donations, and green bonds are one of the best examples of sustainable finance instruments. Subject to the same market regulations as traditional bonds, green bonds are issued to finance predefined projects such as waste reduction, energy efficiency, biodiversity, and carbon free transportation. Since these bonds finance environmentally friendly projects, it has been argued that by buying these bonds, investors will generate not only financial returns but a positive social impact as well (Paranque and Revelli, 2019). As such, it may be plausible to expect that investors may be willing to forgo some financial return in order to participate in the generation of this social impact. This thesis aims to contribute to the strand of literature that analyzes whether green bonds provide their issuers a financing alternative with a lower cost of capital.

The existing literature on the issue provides mixed results. Some researchers (Preclaw and Bakshi, 2015; Ehlers and Packer, 2017; Zerbib, 2019; Kapraun and Scheins, 2019; Gianfrate and Peri, 2019; Agligardi and Agligardi, 2019; Baker et al., 2018; Partridge

and Medda, 2019) find that green bonds are traded at higher prices, and thus lower returns, compared to brown bonds of the same companies. On the other hand, some researchers (Hanhenberg and Schiereck, 2018; Karph and Mendel, 2018) argue that green bonds do not offer a lower cost of capital for the issuers.

One reason for the mixed evidence may be the lack of standardization practices in the green bond market. Even though the cumulative green bonds issuance has reached approximately USD 1.4 trillion by the end of 2021 (CBI, 2021), there is no single global definition of green bonds. Different standards have gained acceptance among market participants. As a result, the fear of greenwashing is strong among investors. The Internal Capital Market Association (ICMA) formulated four pillars of green bond principles to overcome market confusion. Based on these principles, Climate Bonds Initiative (CBI) provides certification to green bonds. In this study, the effect of CBI certification and issuers' ESG ratings on green bond returns is investigated.

Results suggest that investors have an incentive to invest in green bonds and this demand is reflected in green bond returns. When the return comparison is done based on whether the green bond is certified by the Climate Bonds Initiative (CBI), contrary to expectations, it is not possible to show any significant effect of this certification on the yield differential. The study also compares green and brown bond returns based on whether the bond's issuer has an ESG rating. Results indicate that the presence of an issuer ESG rating increases both green and brown bond returns. However, ESG presence does not make any additional contribution to the greenium. Lastly, by breaking down ESG presence into ESG Scores and Environmental Pillar Scores, a within-sample comparison of green and brown bond returns is performed on a before- and after-pandemic basis. Findings show that following the start of the pandemic, green bond returns have increased, implying a stronger demand for green bonds. Also, higher ESG Scores and Environmental Pillar Scores significantly increased returns of green and brown bonds after the pandemic.

CHAPTER 2

GREEN BONDS

2.1. Green Finance

2.1.1. Relationship between sustainable, green and climate finance

The terms sustainable, green and climate finance are used interchangeably. United Nations Environment Program (Forstater and Nuohan, 2016) draws a schema as illustrated in Figure 1. “Sustainable finance” is a holistic approach which entails environmental, social, economic and governance indicators in financial decision making. Sustainable finance merges traditional investment approaches and philanthropic donations. While the former seeks purely financial outcomes, the latter seeks purely social, environmental or governance impacts.

On the other hand, “green finance” focuses on climate change mitigation, climate change adaption as well as other environmental concerns. Within the climate change mitigation dimension, the aim is to reduce greenhouse gas emissions. Some examples that fall under this category are renewable energy, energy efficiency, green buildings, clean transportation, and forest preservation. Climate change adaptation dimension focuses on strategies to deal with the inevitable consequences of climate change such as climate resilient agriculture and urban infrastructure. The last category under environmental dimension addresses environmental issues apart from climate change. Biodiversity conservation, air and water pollution control can be given as examples. Nested under green finance, “climate finance” is only concerned with climate change related issues.

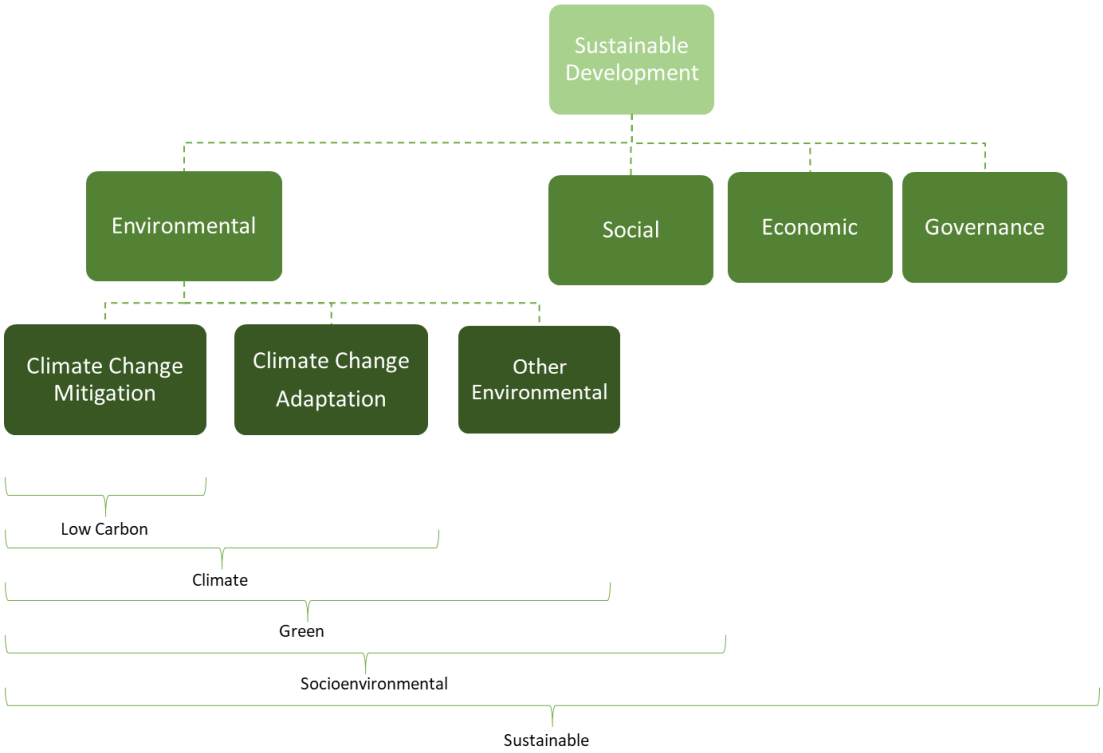

Figure 1: Relationship between sustainable, green and climate finance (UNEP Inquiry, 2016).

2.2. Green Bond Market

2.2.1. The story behind the first labelled green bond

In 2006, Swedish investors were looking for ways to incorporate environmental concerns into their portfolios. Kerstin Hessius, CEO of AP3, and one of the concerned investors explain that at that time the understanding of a sustainable portfolio was excluding companies causing carbon pollution rather than directly investing in green projects. However, exclusion strategy was not effective, and they were looking for a liquid, easy to understand and credible financial product to engage in environmental issues. Christopher Flensborg, Head of Sustainable Products at SEB, seized the opportunity and drafted an idea of what could be done. After presenting his idea and taking approval of investors, he went to the World Bank. In 2008, with the

collaboration of SEB, World Bank and Scandinavian investors, World Bank issued its first green bond, which was worth SEK 2.3 billion. The aim was to provide a product that investors can engage in environmental issues and environmental concerns in their mainstream portfolios.

A year before World Bank issued its first green bond, in 2007, the European Investment Bank (EIB) launched a bond called Climate Awareness Bond (CAB) which was worth EUR 600 million. Although it was not labelled as a green bond at the time, the Climate Awareness Bond of EIB ignited the green bond market. EIB's Climate Awareness Bond was a structural note where the proceeds financed renewable energy and energy efficiency projects (IFC, 2016).

2.2.2 What is a Green Bond?

There is not any universal green bond definition nor an authority that will decide what makes a bond green. One of the widely accepted definitions is green bonds are regular bonds where the use of proceeds is used to finance green projects or activities that are aligned with predefined set of criteria (ICMA, 2018). Green bonds are subject to the same financial regulations as other listed securities. The intended use of proceeds is what distinguishes green bonds from regular bonds. Since the issuance of Climate Awareness Bond in 2007, the market has grown rapidly. Different parties have involved in defining what green bond is. Governments, corporate issuers, NGO's, policy makers, financial regulators, banks, and investors they all have their authentic definitions. Each definition has different scopes, restrictions, and transparency levels. Participants in green bond market is illustrated in Figure 2.

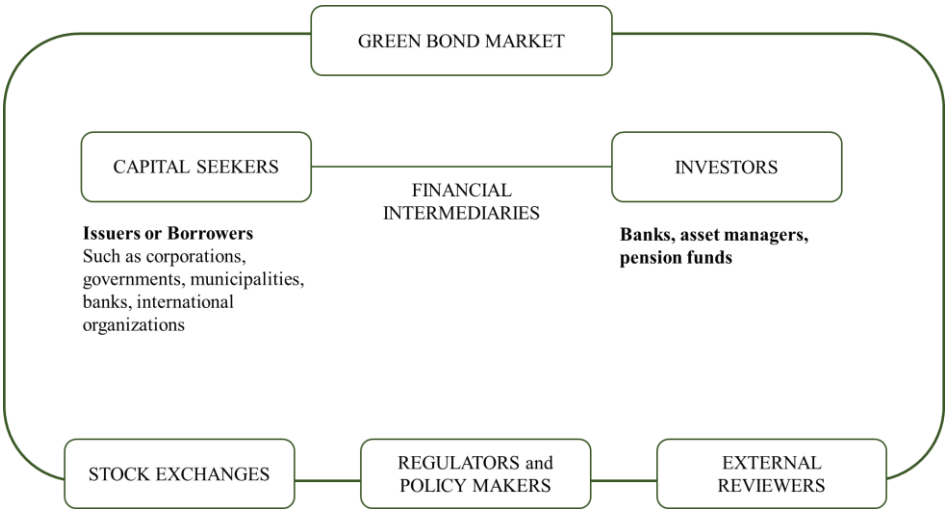

Figure 2: Participants of Green Bond Market.

2.2.3. Types of Green Bonds

There are four types of green bonds in the market (ICMA, 2018):

Green Use of Proceeds Bond

The proceeds from these types of bonds are used to finance eligible green projects and they are backed by issuer entities' balance sheet. These bonds are standard "recourse to the issuer debt obligations".

Green Revenue Bond

A green revenue bond is a "non recurse to the issuer debt obligation". The proceeds can be used to finance related or unrelated green projects. Debt securities are repaid with the cash flows of specified revenue streams, taxes or cash flows.

Green Project Bond

These bonds are used to invest in specific green projects. Investors have direct risk exposure the projects because they are repaid by exactly the projects they invested.

Green Securitized Bond

These bonds are collateralized securities by a group of green projects or assets.

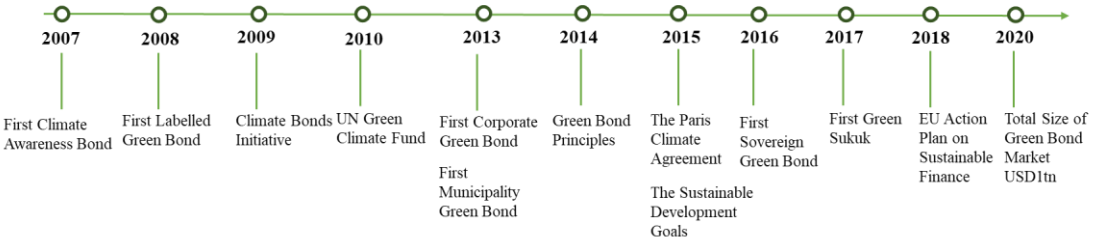

Figure 3: Mile Stones of Green Bond Market.

Once esoteric financial instruments, green bonds become the realm of green finance market. Since the inception in 2007 with the issuance of Climate Awareness Bond, total size of the green bond market has reached USD1 trillion at the end of 2020. The market has continued to grow. In the third quarter of 2021, the cumulative green bond market volume has reached USD1.4 trillion (CBI, 2021). This cumulative increase owes its growth to continuously accelerating growth in annual green bond issuance. Until 2013, Multilateral Developments Banks such as World Bank and European Investment Bank were the only green bond issuers. In November 2013, Vasakronan, a Nordic real estate company, issued the world's first corporate green bond (Vasakronan, 2018). This year was the turning point for the green bond market. Other big corporations followed the example of Vasakronan. For instance, in March 2014 Unilever issued £250 million green bond. The company's aim was to decrease their waste, water usage and gas emissions by building new factories with the money raised from green bonds (Daneshkhu and Bolger, 2014). With the issuance of corporate green bonds in 2013, the green bond market has started growing rapidly. 2013 was also the year in which the fist green municipality bond was issued by Massachusetts. The green bond proceeds were used to finance projects such as clean water, energy efficiency in state buildings, land remediation, and habitat restoration (Green City Bonds Coalition, 2017). In the upcoming years, green bonds attracted governments as well. Poland become the first country to issue a green sovereign bond. In 2016, the Polish government raised EUR50 million to finance projects such as rail infrastructure, sustainable farming, protection of water and soil, protection of forest and wildlife (Ministry of Finance Republic of Poland, 2019).

2.2.4. Current Situation of the Green Bond Market

According to the 2020 Green Bond Market Report of Climate Bonds Initiative, cumulative green bond issuance reached USD1 trillion. Moreover, by the third quarter of 2021 the total green bond issuance has reached USD1.4 trillion.

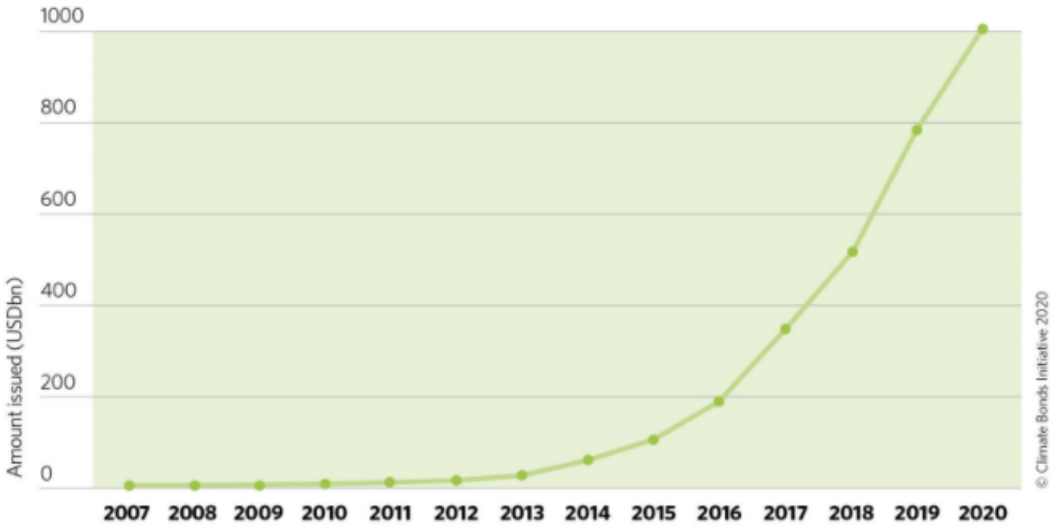

Figure 4: Cumulative Green Bond Issuance between 2007 and 2020 (Climate Bonds Initiative, 2021).

In the case of regional breakdown, Europe became the largest green bond issuer of the year with USD156 billion and 48% of the total issuance of 2020. It is not a surprise and in line with the EU's commitment to become the first carbon neutral continent by 2050. (EUROPEAN COMMISSION, 2019). When policy makers support green investments, more opportunities are created for the private issuers. Based on the analysis of McKinsey, 28% of EU's greenhouse gases emission comes from transportation (McKinsey, 2020). As the EU strives to decrease greenhouse gas emissions, a ban for sales of fossil-foil cars is looming. In line with these developments automotive sector has increased its presence in the green bond market. For example, Mercedes-Benz's parent company international car manufacturer, Daimler issued its first green bonds in September 2020 and March 2021 each with a volume of EUR1 billion. The company claims that the use of proceeds will finance the production of electric vehicles (Daimler AG, 2021).

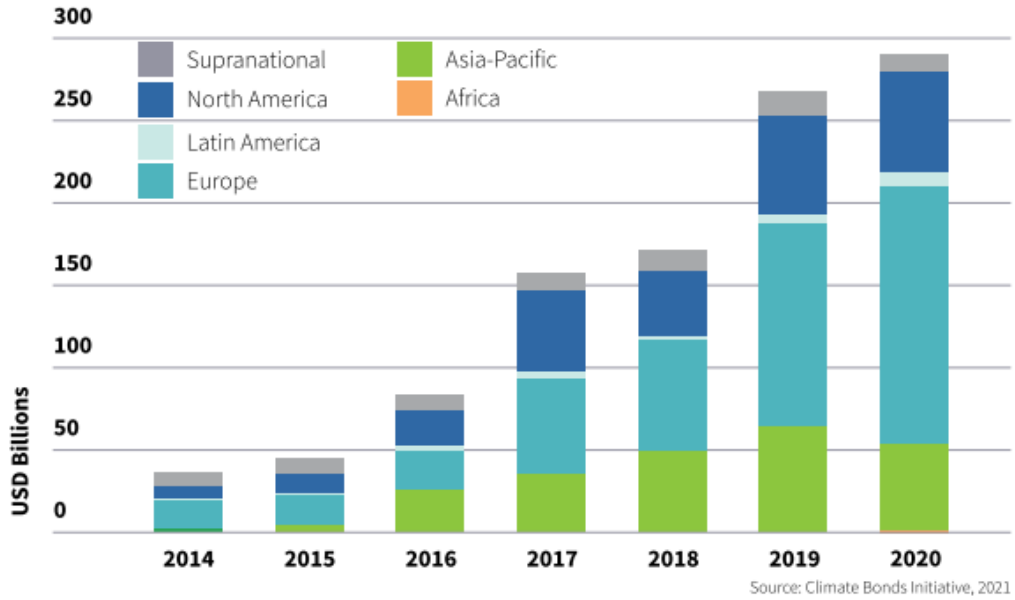

Figure 5: Yearly Green Bond Issuance between 2014 and 2020 and Regional Breakdown (Climate Bonds Initiative, 2021).

The second greatest contribution to the green bond market came from the North America with total issuance of USD61.5 billion. When it is compared to the long-term fixed income issuance of USD12.2 trillion in 2020 (SIFMA, 2021), the size of USD dominated green debt has still room to grow. However, considering the unwillingness of the Trump administration to support environmentally friendly policies, again this is not a surprise. On the positive side, Joe Biden's sustainability agenda might be the beginning of a new era for the US economy. The net zero emission target of Biden (White House Statements and Releases, 2021) gives a lucid message to the US economy and encourages to invest in sustainable future. Furthermore, the Latin America region contributed USD7.9 billion green bond issuance in 2020 most of which came from Chile only. Africa made a huge progress compared to previous years and issued USD1.2 billion green bond. Whereas the green bond issuance in the Asia Pacific Region decreased to USD53.2 billion in 2020 (CBI, 2021). Issuer breakdown and currency breakdown of green bonds are show in Figure 6 and 7 respectively. While corporates lead the green bond market Euro is the leading currency.

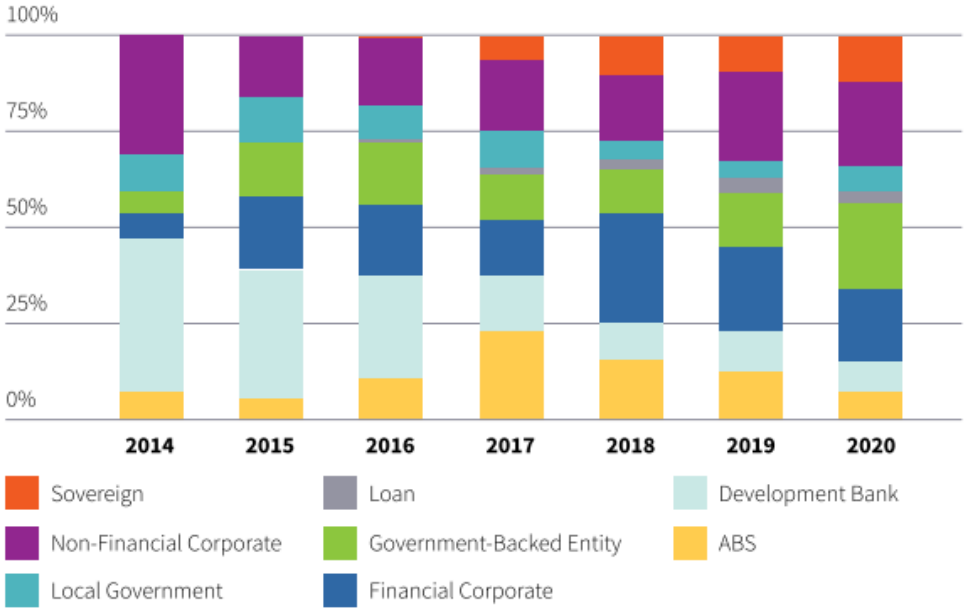

Figure 6: Green Bond Issuer Breakdown between 2014 and 2020 (Climate Bonds Initiative).

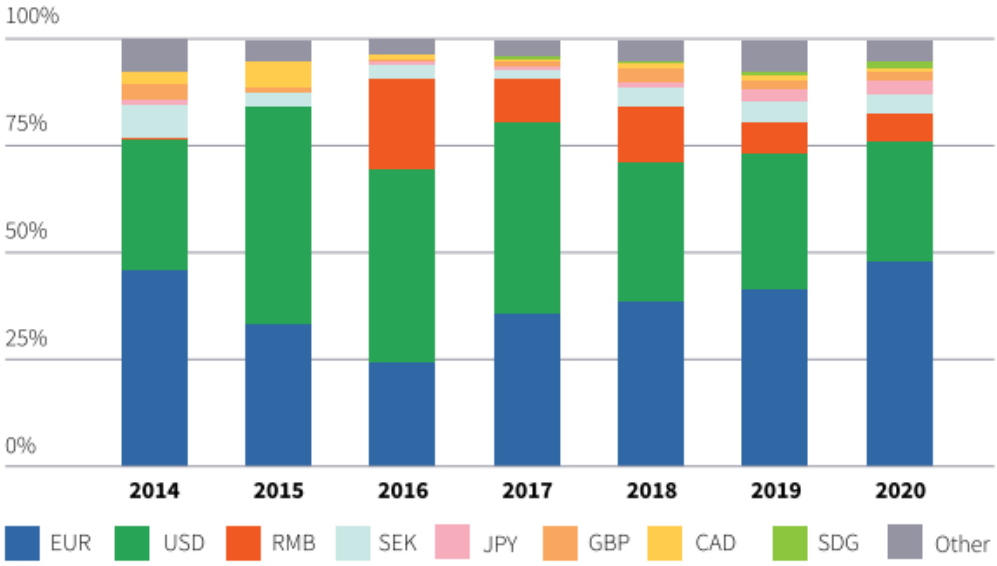

Figure 7: Green Bond Currency Breakdown between 2014 and 2020 (Climate Bonds Initiative).

2.2.5. Standardization Efforts for Green Bonds

It is important to keep in mind that there is no single and legal definition of a green bond. Different parties including financial service providers, stakeholders, banks, policy makers, NGO's involved in defining what green bond is in their own terms.

Scope of these definitions, their transparency levels and details vary. With that being the case, a need for the standardization of green bonds arises in the market. In 2014, International Capital Market Association (ICMA) released a set of voluntary guidelines, the Green Bond Principles (GBP). Not only the GBP provide a framework for capital seekers regarding the key steps of issuing a green bond but also the principles help investors to evaluate the environmental performance of their investments (ICMA, 2018).

The GBP identifies core pillars of green bonds in four components:

1. Use of Proceeds

The principles state that all projects that are financed by green bonds should provide environmental benefits. The definitions of these green projects should be clearly explained to the investors. Issuers should provide information regarding whether proceeds are used to finance new projects or refinance existing ones. The eligible green projects are also listed by the GBP as follows: renewable energy, energy efficiency, pollution prevention and control, environmentally sustainable management of living natural resources and land use, biodiversity conservation, clean transportation, climate change adaptation, green buildings and circular economy adapted products. However, the GBP also highlight that the list can be extended depending on the sector and geography.

2. Process for Project Evaluation and Selection

This pillar addresses the importance of crystal-clear communication with the investors. The issuers are advised to inform the investors regarding the environmental objectives of the projects, how the projects financed by the green bonds fall into the eligible categories listed in the first principle.

3. Management of Proceeds

The GBP encourage transparency in tracking the net proceeds of green bonds. The principles suggest that these proceeds should be moved to a specific sub-portfolio or a sub-account. Also, issuers should notice the investors about the net amount of allocated and unallocated proceeds.

4. Reporting

This principle addresses the importance of providing up to date information on the use of proceeds, project descriptions financed by the green bonds, how the proceeds are managed and environmental impacts of the projects. GBP encourages publishing annual reports.

GBP also suggest that issuers should appoint external reviewers to evaluate the compatibility of green bonds with the four components of GBP. Issuers can consult individual advisors or institutions to ensure the greenness of their bonds. Independent external reviews have different scopes of assessing green bonds. According to ICMA, there are four widely used external reviews in the green market. These are Second Party Opinion, Verification, Green Bond Scoring/Rating, and Certification.

As suggested by GBP, external reviewers can provide independent opinion on green bonds by conforming the alignment of green bonds to GBP components. Examples of external reviewers are CICERO, Sustainalytics, VIGEO, Oekom, and DNL GL. In addition to these external reviewers, issuers can apply to index providers and rating agencies such as Moody's, Barclays, the Bank of America Merrill Lynch and S&P for assessing rating of their bonds. However, these second opinion providers and third parties do not provide any certification to the green bonds. Currently only the Climate Bond Initiative (CBI) gives certification to the green bonds. CBI has been launched in 2009. In 2014 CBI provided certification for the first time to a solar developer company, Belectric's bond of 4 million pounds. In September 2015, one of New Zealand's energy companies, Contact Energy issued the first CBI certified corporate green bond. As of third quarter of 2021 the cumulative CBI certified green bond market has reached USD 190 billion (CBI, 2021) as given in Figure 8.

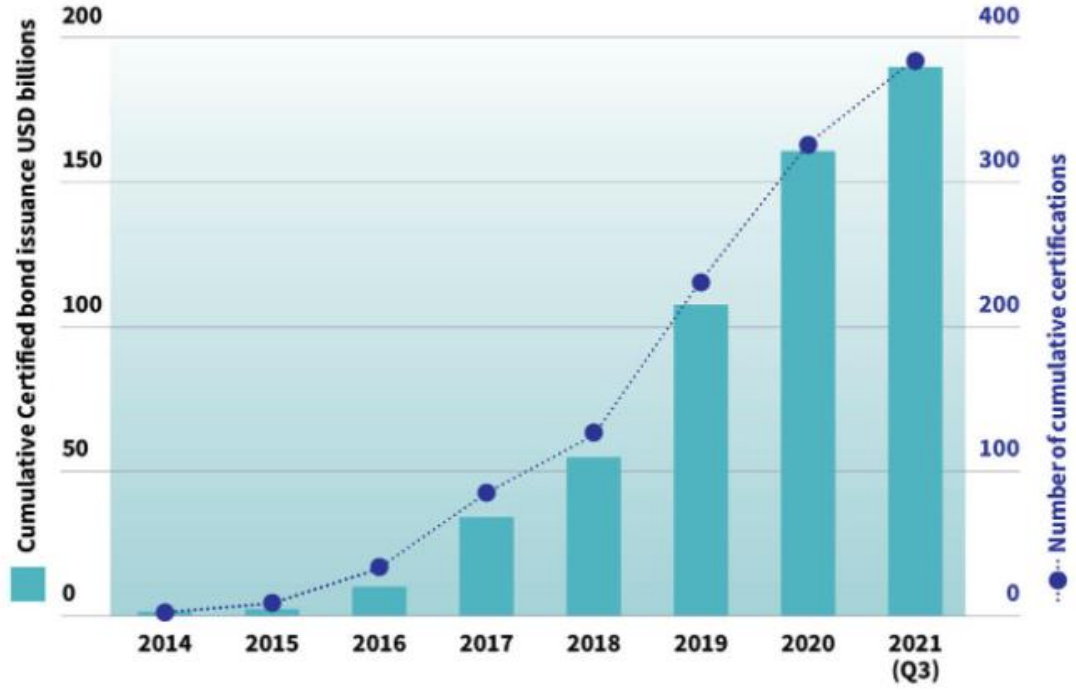

Figure 8: Cumulative Certified Green Bond Issuance between 2014 and Q3 of 2021 (CBI, 2021)

Considering the cumulative size of green bonds, USD 1.4 trillion, the certified green bonds are only 13.5% of the current green bond market.

CHAPTER 3

LITERATURE REVIEW

3.1. Socially Responsible Investment

Although green bonds are a new concept. Socially responsible investing practices are observed in the market for long time. The roots of socially responsible investing (SRI) go back to decades ago. SRI evolved from religious based do no harm acts to today's modern value-based investing practices. Social movements, civil rights, humanitarian crises, antiwar protests have been the driven factors for the investors' motivation responsible investing. Since the beginning of 2000 in which the climate concerns became visible, investors have started to integrate sustainable issues and financial concerns (Townsend,2020). From this sense, for the last two decades ESG investing has become a popular topic among researchers due to the increasing popularity of sustainability concerns.

Sharfman and Fernando (2008) find evidence that firms with better environmental performances enjoy lower cost of debt financing. Investors reward companies when they act greener. Menz (2010) study whether the effect of corporate social responsibility (CSR) is significant on corporate bond returns. They find that higher CSR ratings do not add any value to the corporate bond returns. In other words, issuers with high CSR ratings do not benefit from lower cost of capital. On the contrary to Menz (2010), El Ghoul et al., (2011) argue that firms with higher CSR ratings and particularly engaging in environmental issues benefit from lower cost of capital.

Polbennikov et al. (2016) investigate how ESG considerations affects the corporate bond returns. They scrutinize whether corporate bonds issued by issuers with high

ESG Scores offer lower cost of capital. They find that bonds issued by companies with high ESG scores have lower spreads.

Hartzmark and Sussman (2019) argue if investors' preferences for sustainability is reflected in the market. Their results suggest that investors value sustainability. Funds with high sustainability rates are deemed to perform better than funds with lower sustainability ratings by the investors. That is why, funds categorized as high sustainability attracts more investors and receive more fund inflows than funds listed in low sustainability class.

3.2. Green Bond Literature

Green finance tends to alleviate environmental problems by increasing flow of funds to environmentally friendly projects. Since the inception of the green bond market, whether green bonds offer lower cost of capital or whether investors are willing to pay higher prices for green bonds has been a debatable topic between the academicians, policy makers, and industry players. Researchers have been attracted by the growing size of green bond market and examined pricing dynamics of green bonds. Green bonds from the same issuers bear the same default risk. Then why are researchers interested in green premium? If issuers want to finance their environmentally friendly projects, they could issue perfectly normal conventional bonds and then raise money to finance these projects. Why would they choose to issue this relatively new type of financial instruments instead of conventional bonds? Which characteristics of green bonds cause this price difference (if any) compared to conventional bonds? What are the determinants of green bond premium? The results and methods of previous studies looking for answers to these questions and more have been different so far. Academicians have examined green premium at primary markets or secondary markets by using different data samples at varying observation periods. Most of the studies have analyzed green bond yields by conducting bond matching methodology. However, there is no consensus in academia whether green bond premium exists or not. One thing is for sure, though, heterogeneity of results.

Green premium or greenium is the yield difference between green bonds and their conventional brown bond counterparts. Negative greenium means that green bonds are traded at lower yields and higher prices. In other words, investors accept lower returns by holding green bonds for the sake of investing in environmentally friendly projects. For the supply side, on the other hand, existence of greenium suggests that issuers are rewarded with lower cost of capital if they are willing to drive change in their organizations towards a more sustainable future. Hence, it is important to understand pricing dynamics of green bond market to catalyze the transition towards a sustainable future.

Maltais and Nykvist (2020) interview with green bond market participants in Sweden. The sample includes nine green bond issuers that issued green bonds in SEK, nine Swedish green bond investors, two Swedish bank representatives, and a Swedish government regulator. They conduct 22 interviews with these participants during 2017 and 2018. Although the results of this study cannot be generalized to the whole green bond market it still provides insights. Interviewed green bond investors state that knowing how use of proceeds will be spent creates an incentive to invest in green projects and contribute to sustainable finance practices. Also, investors claim that they are willing to accept lower returns for the sake of sustainability. On the other hand, from the issuers' perspective, the biggest driver of issuing green bonds is financial incentives. As a result of additional reporting and verifying cost, green bond issuers want to be rewarded with lower cost of capital.

One of the first study investigating the pricing difference between green bonds and conventional bonds is conducted by Preclaw and Bakshi (2015). They focus on yield spread of green bonds compared to conventional bonds issued between March 2014 and August 2015 in secondary bond market. Their sample universe is Global Green Bond Index downloaded from Bloomberg database. They find that investors pay a green premium. Through an OLS regression model by controlling credit risk, investment length and the time since issuance they report that green bonds have a negative premium of 17 bps. Between March 2014 and August 2015 green bond premium increased while the green bond market has been growing. Moreover, they consider demand and supply mismatch of green bonds is the cause of this pricing

difference. Due to the shortage of green bonds' supply in the market when they conduct this study, the writers indicate that issuers can offer green bonds at lower interest rates.

Ehlers and Packer (2017) analyze the difference in credit spread of green bonds and conventional bonds in the primary market. Their data set consists of 21 fixed rate Euro and USD denominated green bonds issued between 2014 and 2017. They match these green bonds with conventional bonds of the same issuers with closest issue date to the green bonds. Their results show that green bonds priced at a premium on average compared to conventional bonds at issuance. They find a negative premium of 18 bps at issuance for green bonds. Similar to Barclays (2015), Ehlers and Packer (2017) consider that the evidence of green premium is the result of green bond shortage in the market. They carry the analysis further into the secondary market. They compare the hedged returns of green bond indices by Bank of America Merrill Lynch, Barclays MSCI, Solactive, and Standard & Poor's with hedged returns of global bond indices. They do not find any significant difference between the returns and conclude that green bonds perform similar to conventional bonds in the secondary market.

One of the early studies about green premium in the secondary bond market is conducted by Zerbib (2019). Their sample consists of 110 green bonds downloaded from Bloomberg database, including supranational, sub-sovereign, municipal, corporate, financial, and covered bonds issued between July 2013 to December 2017. They use a matching method. They pair each green bond with two synthetic conventional bond of identical characteristics: currency, rating, bond structure, seniority, collateral, coupon type and closest maturity. To account for the effect of liquidity on the yield spread of matched pairs, they focus on issue amount and issue date. Their matched conventional bond has an issue amount of four times less than the corresponding green bond's issue amount or greater than one quarter of this amount. Whereas they set the conventional bond's issue date at most six years earlier or six years later than that of corresponding green bond. By conducting two step regression analysis they find that on average -2 bps green bond premium in their sample. Also, this negative premium is greater for financial bonds and low rated investment grade bonds. They highlight the demand and supply side mismatch for green bonds similar

to Barchlays (2015). There is a shortage in the supply side which cannot meet the increasing demand of investors. Many studies about green bond premium, follow the footsteps of Zerbib (2019) and apply matching method.

A group of researchers study US municipal green bond market as well. Different than previous studies, Karpf and Mandel (2017) focus on the US municipal bond market and investigate the differences in yield structures of green and conventional municipal bonds in secondary market prices. They use Bloomberg green bond data base and analyze 1880 green bonds issued by 189 distinct issuers and relative conventional bonds with the same characteristics issued by the same set of issuers on municipal bond market. Through Oaxaca-blinder decomposition they find positive 7.8 bps premium on green bonds issued between 2010 and 2016. Partridge and Medda (2018) study green premium in the primary and secondary US municipal bond markets. They perform yield curve analysis of green municipal bonds and their conventional counterparts by the same issuers. They analyze 521 pairs of green and conventional bonds having identical issue size, use of proceeds, issue date, maturity date and coupon rate. Their result indicates there is positive 5 bps green premium in secondary market whereas 1 bps premium in primary market in 2017. Baker et al., (2018) are one of the researchers studying US municipal green bonds market. They analyze 2083 green municipal bonds issued between 2010 and 2016 and 19 green corporate bonds issued between 2014 and 2016. In contrast to Karph and Mandel (2017), using a pooled fixed effect model they confirm that green municipal bonds are priced at premium. They find evidence of -6 bps in green bond yields after tax basis. They control for maturity, tax status, yield curve, and bond specific characteristics in their model. They find that this 6 bps difference in yield doubles for bonds externally verified, which suggest that formal green bond verification is important in this emerging market. Moreover, they find that green bond ownership is more concentrated. A subset of investors is willing to sacrifice financial returns in exchange of holding green bonds. In contrast to the previous studies on municipals green bonds, Larcker and Watts (2020) show that investors view the green and brown bonds of the issuer as identical. In fact, their result show that investors are unwilling to invest in environmentally projects. They collect green municipal bonds from Bloomberg database issued between 2013 and 2019. Their sample consists of 640 matched pairs of green and conventional bonds issued on

the same day with identical maturity and issued by the same municipality. They do not find any significant yield difference between green and brown municipal bonds. On the other hand, their results cannot be generalized for the entire market since municipal securities are different than other asset classes. They leave the gap for studies whether a greenium exist in other markets especially corporate green bond market.

In what extends green bonds provide diversification benefits for the investors in other words in what extends green bonds market is dependent on the financial markets has been the question of Reboredo and Ugolini (2020). They study green bonds represented by Barclays MSCI green bond index, S&P Dow Jones green bond index, Solactive green bond index and Bank of Merrill Lynch green bond index and use structural vector autoregressive model to observe price dynamics in the financial markets. They find that green bonds are not affected by price fluctuations in the stock, energy and corporate bond markets. Therefore, having green bonds in the portfolio can provide diversification benefits for the investors. Tang and Zhang (2020) examine the stock market responses to green bond issuance and the green bond premium. They combine the two global green bond universes available on CBI green bond database and Bloomberg database between 2007 and 2017. Their initial dataset consists of 1510 green bonds issued by development banks, municipals, commercial banks, corporations, state backed securities, state backed entities and sovereigns. For the country breakdown, supranational, China, United States, Sweden and France are the top five number of green bond issuers. Then, they restrict the dataset to first time green bond issuers of financials and industrial corporations. The final set consists of 132 unique public issuers and 241 green bonds. The average coupon rates, maturity and issue amount for the sample of 241 green bonds are 3.2%, 6.56 years and 369 million dollars respectively. To analyze the stock returns, they conduct an event study analysis. Starting from 10 days prior to the green bond announcements until 10 days after the announcements they calculate daily and estimated stock returns. They find statistically significant 1.39% positive cumulative abnormal return. This result shows that stock market investors react positively to green bonds issuances and award companies. Tang and Zang (2020) also check for the evidence of green premium. This time they collect normal and corporate green bonds of 41 firms issued between 2007 and 2017 from SDC Platinum Global Issuance database. When regress bond yield spreads at issuance

to green bond dummy, equity volatility, bond rating, maturity, issue size, firm size, leverage, profitability, country fixed effects, year fixed effects and issuer fixed effects, they do not find any significant green bond premium. Another study examining the stock market reaction to green bond announcements is carried out by Flammer (2021). She collects 1189 corporate green bonds of 400 unique issuers from Bloomberg database issued between January 1, 2013 and December 31, 2018. Total issue size of the bonds is $301.2 billion. The dataset includes all corporate green bond universe available on the Bloomberg database. The top five issuer countries based on issue amounts are China, Netherlands, United States, France and Germany. For the number of green bond issuances the top five tiers are China, United States, France, Sweden and Germany. Then she converts all currencies to dollar. 65.6% of 1189 corporate green bonds are externally verified by third parties such as Sustainalytics, Viego Eiris, Ernst and Youg, and Cicero. It is important to distinguish the difference between certification and external verification. The author in her article actually use the term certification when green bonds are externally verified by independent third parties. Furthermore, she does not explain whether any of these bonds are actually certified by CBI. Academicians are inclined to use the terms of certification and external verification interchangeably. However, these two concepts are different, and it is important to distinguish while using. Then, she excludes private green bond issuers from the sample and continues the analysis with 565 green bonds issued by 169 unique public firms. To examine the stock market reactions, she conducts an event study methodology. She calculates the daily and estimated stock returns of the companies starting from 5 trading days before the announcement date of green bond issuance until 10 trading days later than the announcement date. By taking the difference between daily returns and estimated returns, she calculates abnormal stock returns. She finds that for this time interval, on average the cumulative abnormal stock return is significantly positive 0.49%. Moreover, for certified green bonds the average of cumulative abnormal stock returns is 0.71% and significant at 5% level while for the non-certified green bonds the result is insignificant. This means that stock market returns increase in light of green bond announcements and green bond certification is welcomed by stock market investors. Later on, she looks for the corporate green bond premium. Based on the bond yield at issuance information available on Bloomberg, she reduces her sample size to 152 corporate green bonds issued by 65 unique public

firms. Following the methodology of Larcker and Watts (2020) she matches each green bond with a conventional bond of the same issuer considering the issue amount, credit rating, coupon rate, and the number of days between the issuance of green and brown bonds. She then calculates the mean and median values of issue yields. Similar to the results of Larcker and Watts (2020) she does not find any difference between the pairs.

In 2016, growing green bond market took attention of the European Commission as well (Cochu et al., 2016). They state that because of lacking regulatory and standardization practices green bond market faces with challenges which prevents the market from growing further. In their report, they identify fundamental problems that hamper the growth of the market. On the supply side, the authors acknowledge that some issuers cannot issue green bonds with good credit ratings due to lack of identifiable green projects and aggregation mechanisms, in addition to lack of universally agreed frameworks for green bonds. On the demand side, they suggest that the main problems are information asymmetry in the market and risk-return concerns. Indeed, they argue that investors should be provided with clear reports demonstrating how issuers fulfill the requirements and comply with their green objectives. Otherwise, investors will be discouraged from investing in green bonds and green bond market growth will be hampered.

Deschryver and Mariz (2020) interview eleven market players including investors, issuers, banks, and consulting firms. They do not explicitly specify the background of interviewees. In light of the interviews, they identify existing problems in the green bond market. According to the issuers, the most challenging obstacle of issuing green bonds is the cost of the process itself that comes with training staff to prepare the necessary pre-issuance requirements, complying with the frameworks, monitoring, reporting, and applying for second party opinion. They also mention the challenge they face while trying to follow complex green bond regulations and rules. On the other hand, investors complain about the lack of supply in the market. Moreover, investors and intermediaries articulate their fear of greenwashing. The term greenwash was used to describe misleading information about corporations' environmental performances. Based on the definition of (Lyon and Montgomery, 2015) greenwashing is selectively

disclosing environmental actions. Finally, the interviewed intermediaries point out that lack of standardization poses a challenge to the green bond market.

The study conducted by Sangiorgi and Schopohl (2021) support the problems defined by Cochu et al. (2016) and Deschryver and Mariz (2020). Sangiorgi and Schopohl (2021) carry out a survey analysis. They examine the survey responses of 48 European asset managers. 9 out of 10 investors express an investment interest in green bonds. Their evidence suggests that degree of greenness of bonds is important for their decision making. 79% of survey respondents state that they do not consider investing in a green bond, if the use of proceeds of the bond are not clearly reported. Moreover, 55% of investors claim that they are more likely to sell green bonds with low quality post issuance reports. Their results indicate that investors require pre issuance and post issuance reports exposing the green qualities and use of proceeds of green bonds. If they are provided with this additional information, they would invest in green bonds. Hence, it can be said that investors are skeptical about greenwash and disclosing information will alleviate investors' skepticism.

In that regard, build upon previous studies and mixed results regarding the existence of greenium, researchers started investigating the effect of information asymmetry on the green bond market to provide an answer to the green bond premium mystery. In that respect, part of literature stream focus on third party opinions, second party verifications, and certification of green bonds, while few studies touch upon the effect of ESG ratings on green bond performance.

Hachenberg and Schiereck (2018) conduct another comparison study on pricing of green bonds and conventional bonds. They collect data from Bloomberg. Their final data set consists of 63 plain vanilla green bonds of which 39 issued by development banks, supranational organizations, and cities, 12 issued by financial firms, 8 by corporations and 4 by real estate companies. They match each green bond with 2 comparable conventional bond one with a longer maturity and other one with a shorter maturity. Each comparable conventional bond has the same issuer, ranking, currency, and structure with the corresponding green bond. To account for the liquidity premium, they set 150 million USD threshold for the issue amount since they claim

that the price of smaller issues is subject to distortion. Through comparing daily i-spreads of each pair from October 1, 2015 to March 31, 2016 they show that green bonds on average do not trade tighter than comparable conventional bonds. On the other hand, they find evidence that A-rated green bonds trade statistically significantly 3.88 bps tighter than their conventional counterparts. For the bonds with AA and BBB ratings they do not find any significant pricing difference. Furthermore, their results suggest that government related bonds trade wider than their conventional brown bonds but corporate and financial green bonds trade tighter than comparable brown bonds. Another important finding of their study is the effect of ESG rating on spreads. In their analysis with a dummy ESG variable equal to 1 for green bonds having at least one ESG rating from Sustainalytics or RobecoSAM, they find that green bonds with ESG rating have wider spreads than non green bonds.

A few years later, built on their previous study together with Immel and Kiesel, Hachenberg and Schiereck (Immel et al., 2021) have published another paper about the green premium. To perform their analysis, they start with all green bonds issued between 2007 and 2019 listed on Bloomberg database. Later, they reduce their sample size to 466 green bonds. Similar to the analysis of Preclaw and Bakshi (Barclays 2015) they use Global Aggregate Index and define a green bond dummy varible. The results show that green bonds have a negative green premium varying between – 8.03 bps to -13.71 bps.

Kapraun et al., (2021) analyze pricing of green bonds in primary and secondary market. Through matched pair analyses they compare yields of green and conventional bonds. They use fixed coupon rated 1500 green and 200,000 conventional bonds and find that green bonds trade at 18 bps lower yields on average in primary market. Their evidence suggest that this difference vary across currencies and issuer types. For bonds issued by governments or supranationals investors are willing to pay premium and accept 20-40 bps lower yields. On the other hand, the premium for small and medium corporate green bond issuers is not significant. In the case of secondary market, they find that green bonds trade at a discount having 10 bps higher yields than conventional bonds on average. Furthermore, they find that green bonds having third party

verification such as Sustainalytics, Cicero, Viego Eiris trade at 22 bps lower yields than green bonds without third party verification.

Bachelet et al., (2019) look for the effect of third party verification and issuer types on the green bond pricing, volatility and liquidity on secondary market. Similar to the previous green premium studies they conduct a matched pair analysis. In their green bond data set, green bonds are considered certified if they are directly certified by CBI, if they are not certified by CBI but still meet CBI requirements, and finally if they are verified by second parties and meet CBI requirements. This data inclusion approach is questionable because Bachelet et al. (2019) consider green bonds as certified although these bonds are not directly provided certification by CBI. For each green bond, they find a closest non green bond having the same issuer type, same currency, same coupon type, and same rating. To account for the coupon rate, amount issued, and maturity date, they followed Zerbib (2019) and put thresholds. They allow amount issued of the non green bonds to be up to four times larger or four times smaller than the relative green bond. For the coupon rate, they consider brown bonds with 0.25 larger or smaller than relative green bond rate. Lastly, for maturity date they include brown bonds issued 2 years before or later than the relative green bonds. Their final data set consists of 89 green and non green bond pairs. Their observation is carried out between1 January 2013 to 31 December 2017. Their data is downloaded from Datastream. By conducting OLS regression, overall, they find that green bonds have 4.65 bps green premium, higher liquidity but at the same time they are less volatile. When they look at the issuer breakdown, institutional green bonds enjoy a negative premium of 3.55 bps, but private green bonds have positive premium of 3.19 bps. Furthermore, private green bonds without certification, based on their specifications explained above, have a 3.21 bps positive premium. The writers acknowledge the effect of green bond certification and institutional reputation to reduce the information asymmetry in the green bond market.

Fatica et al., (2021) collect 271,312 bonds issued by supranationals, financial firms and non-financial firms between 2007 and 2018 from Dealogic DCM database. Within this sample they classify 1397 green bonds, of which 637 green bonds have either been certified by CBI or externally verified by third parties. Using this sample they analyze

the pricing differences of green bonds compared to conventional bonds at primary market. They follow the methodology of Baker et al. (2018) and regress the bond yields at issuance to green dummy, callable and puttable dummies, collateralized dummy, issue amount, number of years to maturity, bond rating and time fixed effects and issuer fixed effects. One drawback of this study is authors do not restrict the sample of conventional bonds to conventional bonds issued by only green bond issuers. The result of OLS regression for the whole sample does not reveal any significant green premium. However, when they conduct additional OLS regressions based on issuer types they find evidence of green premium. Green bonds issued by supranationals and non-financial firms have respectively 80 bps and 22 bps lower yields than conventional bonds. However, they do not find any significant yield difference for the green bonds issued by financial institutions. To check the effect of external review, they introduce the external review dummy to the analysis. If green bonds are certified by CBI or externally verified by third parties, the dummy is equal to one otherwise zero. The coefficient of external review dummy is not statistically significant for the full sample, supranationals and financial institutions. However, OLS regression conducted for only non-financial firms show that external review dummy has a coefficient of negative 43.74 bps.

Hyun et al., (2020) follow the matching and two step regression methodology of Zerbib (2019). They collect all green bonds issued between 2010 and 2017 from Bloomberg database. From this sample they exclude non-investment grade bonds, bonds with zero coupon rate or floating coupon rate, and bonds having tied to options. Then, they match each green bonds with conventional bonds of closest characteristics. The final sample is 60 pairs of brown and green bonds. Furthermore, they check whether these green bonds have external verification or CBI certification. However, they do not explicitly say how many of these bonds have CBI certification or verification. This information is not clear. The green bonds issued in AUD, CAD, CHF, EUR, GBP, INR, MXN, TRY, USD currencies. Similar to Zerbib (2019) they conduct two step regression analysis. First, they remove the effect of liquidity premium from yield spreads. After that, they regress the liquidity adjusted yield spread on green bond dummy, issue size, maturity, currency, credit rating, and sector. On average, they do not find any evidence of pricing difference between green and brown

bonds. However, when they introduce external review dummy variable to the equation, they report negative green bond premium of bps.

In a recent study by (Hyun et al., 2021) the effect of green label on the green bond performance has been discussed. They analyzed 3,578 green bonds on Bloomberg database from January 2014 to December 2017. Of which 3,296 carry labels and 282 green bonds are unlabeled. The writers do not clarify what they mean by labelled green bond. It is only the label provided by the bond issuer or these bonds are externally verified by a third party and offered a label are the drawbacks of their dataset. Even though their study has been published online in 2020, they have not included green bonds issued from 2018 onwards. To estimate the effect of label on bond yields they match unlabeled green bonds and labelled green bonds based on propensity scores. After propensity score matching, dependent variable green bond yield is regressed on control variables and labelled green bond dummy. They find that labelled green bonds have 24-36 bps lower yields than unlabeled green bonds. Their result suggests that investors value the higher degree of greenness and ready to pay more because as the quality of a green bond increases the risks associated with information asymmetry is alleviated.

Another latest study about green quality has been carried out by (Simeth, 2021). They investigate the effects of different types of external reviews on green bond pricing on the secondary green bond market. Their data set consists of 121 green bonds listed in Bloomberg database and issued between 2010 and August 2018. Each green bond has been matched with a brown correspondent based on coarsened exact matching. After, pooled OLS regression analysis on brown and green pair they find that on average green bonds have 0.5 bps higher yield than brown bonds. Different than previous studies, noy only they measure the effect of external review on green bond yield but also they divide external review types into three groups, verification, second party opinion, green bond rating, and estimate each one's effect on green bond yields. The analysis has been carried out from the issuance date of the bond until December 2020. Their results show that external review does not have significant effect on greenium. However, when they look at the breakdown of external review types, green bonds with second party opinion have 9 bps lower yields than their brown twins. Also, verification

and green bond rating do not seem to affect green bond yields. The problem of this study as writer states as well the small dataset.

In the previous studies effects of different external review types on green bonds have been analyzed. Authors do not make clear definitions of external reviewers. The terms certification, external verification, and labelled bonds are used interchangeably. By filling the research gap in the green bond literature about the effects of different external review types on green bond returns, in this study the effect of CBI certification on secondary market green bond returns is investigated. By making a clear definition of certification only green bonds provided certification by CBI are accepted as certified green bonds. In addition to the CBI certification, whether the presence of issuer's publicly available ESG scores affects green bond returns is analyzed. Moreover, by further breaking down the ESG presence into ESG Scores and Environmental Pillar Scores, their effect on green and brown bond returns are studied.

CHAPTER 4

DATA AND METHODOLOGY

4.1. Sample Construction

Data on all corporate bonds flagged as green by the Thomson Reuters (TR) database and issued between January 1, 2007 and November 21, 2021 were collected from TR's Government and Fixed Income Securities application. The initial green bond sample included 4,196 corporate green bonds issued by 1,582 distinct issuers. The Excel file containing the data was imported to the Python Spyder environment and the data elimination processes were handled by the Pandas and Numpy libraries of Python. Since this is an empirical data collection, in the first step duplicate bonds and bonds without International Securities Identification Number (ISIN) were discarded from the sample. After that, the sample was reduced to 3,927 corporate green bonds.

The Climate Bonds Initiative (CBI) provided certification for the first time to a corporate green bond in 2015. This study examines the effect of CBI certification on green bond returns compared to their brown correspondents. As a result, corporate green bonds issued before January 1, 2015 were excluded from the sample, which reduced the sample size to 3,833 corporate green bonds. Thereafter, the coupon type was restricted to plain vanilla fixed coupon in order to construct a more homogeneous sample. This step reduced the sample to 2,946 corporate green bonds with plain vanilla fixed coupons. At this step, the principal currencies of remaining green bonds were checked. Since green bonds that are denominated in Euro, US Dollar, Chinese Yuan, Japanese Yen, Swedish Krona, South Korean Won, account for 83.94% of the total sample, green bonds with other denominations were excluded. This step reduced the sample size to 2,473 corporate green bonds issued by 1,082 distinct issuers.

To collect the corporate brown (conventional) counterparts of these 2,473 green bonds, the same steps were followed. In the Government and Fixed Income Securities application of TR, all corporate brown bonds issued between January 1, 2007 and November 21, 2021 were listed. Moreover, in order to account for possible issuer effects in the analysis, the purpose was to download all corporate brown bonds issued by the distinct 1,582 green bond issuers in the initial sample; therefore, a ticker filter was added. According to this filter, bond issuer tickers must be the same as the tickers of the 1,582 green bond issuers. Based on these specifications, initially 1,488,484 corporate brown bonds were listed. Unfortunately, TR does not allow to download more than 4,000 rows of information to excel. As a result, this procedure was completed at various sessions. First and foremost, duplicate downloads and bonds without ISIN numbers were dropped from the sample which reduced the sample size to 1,402,375 corporate brown bonds.

Next, bonds issued before 2015 were eliminated from the sample and 980,272 corporate brown bonds were left. Later on, bonds with coupon types other than plain vanilla fixed coupon were excluded. This step reduced the sample to 343,113 corporate plain vanilla fixed coupon brown bonds. Since the green bonds sample was restricted to bonds denominated in Euro, US Dollar, Chinese Yuan, Japanese Yen, Swedish Krona, and South Korean Won, the brown bonds denominated in currencies other than these were dropped and 258,543 bonds remained in the brown bonds sample.

Each green bond in the sample was required to have at least one brown counterpart issued by the same issuer. To ensure that, out of the remaining 258,543 brown bonds, bonds issued by companies other than the remaining 1,082 green bond issuers were excluded from the brown bond sample. This step reduced the brown bond sample size to 172,199 bonds with 856 unique issuers. Comparing these numbers, 856 unique brown issuers and 1082 green issuers, apparently 226 green bond issuers do not have brown bonds. To deal with this problem, the green bond sample was revisited and green bonds of these 226 issuers were dropped from the green sample. With this step, the green sample was reduced to 2,050 corporate green bonds issued by 856 issuers.

Afterwards, total daily returns of the remaining 2,050 green bonds, between January 1, 2015 and December 31, 2021 were collected based on bond ISIN numbers from the TR database using the TR Excel add in. The rows without total daily return information were omitted. Based on the total daily return data availability, the green bond sample was further reduced to 1,575 green bonds issued by 744 unique issuers.

The next step was to collect brown bond total daily returns. Before downloading the total daily returns, the brown sample of 172,199 bonds were adjusted in accordance with the 744 green bond issuers. Daily total return data of 165,162 corporate brown bonds of 744 distinct green bond issuers were collected by using the TR Excel add in. When the NA entries were removed, the brown bond sample was reduced to 15,001 corporate brown bonds issued by 696 distinct issuers. Furthermore, bonds without the amount issued information were dropped from the sample. The brown bond universe became 14,995 bonds issued by 696 issuers. On the green side, the sample was reduced to 1,430 green bonds issued by these 696 issuers.

At that point, on the green side, there were 1,430 plain vanilla fixed coupon corporate green bonds with principal currencies of Euro, Dollar, Chinese Yuan, Japanese Yen, Swedish Krona, South Korean Yen issued by 696 issuers. On the brown side, there were 14,995 plain vanilla fixed coupon corporate brown bonds with principal currencies of Euro, Dollar, Chinese Yuan, Japanese Yen, Swedish Krona, South Korean Yen issued by the same issuers as the green bonds.

Subsequently, the daily 10-year benchmark government bond bid yields of the selected currencies were collected between January 1, 2015 and December 31, 2021 by using the TR Excel add in. Benchmark currencies were merged with the daily total observations based on the date and the principal currencies of the bonds. For some days, the corresponding bid yield data were missing, these entries were dropped from the merged dataset. At each step, the brown bond and green bond issuers were checked. After merging with government bid yields and dropping missing entries, 1,415 green bonds with 689 issuers and 14,932 brown bonds with 695 issuers remained in the sample. The intersection of the remaining green issuers and brown issuers was found. Bonds issued by the issuers not in the intersection were excluded from the sample. As

a result, 1,414 green bonds and 14,890 brown bonds of 688 distinct issuers remained in the sample.

Finally, bonds with fewer than 504 days of total daily return data were excluded from the sample. With this step, 253 green bonds and 3,375 brown bonds of 162 unique issuers were left to carry out the analysis. The summary of sample construction steps are presented in Tables 1 and 2.

Furthermore, certified green bonds database was download from the Climate Bonds Initiative's website. Out of the 253 corporate green bonds in the final sample, 22 were manually identified to have the CBI certification.

Table 1: Green Bond Sample Construction

This table shows the filters applied for constructing the green bond sample.

	Number of bonds	Number of issuers
Initial sample after duplicates and bonds without ISIN numbers are removed	3,927	1,582
Bonds issued in or after 2015	3,833	
Bonds with Plain Vanilla Fixed Coupon	2,946	
Bonds with principal currencies Euro, Dollar, Chinese Yuan, Japanese Yen, Swedish Krona, South Korean Yen	2,473	1,082
Bonds issued by remaining 856 brown bond issuers	2,050	856
Bonds with available daily total returns data	1,575	744
Bonds issued by remaining 696 brown bond issuers	1,430	696
Bonds in the data set matched with benchmark bid yields	1,415	689
Bonds in the intersection	1,414	688
Bonds with at least 504 days of daily return data	253	162

Table 2: Brown Bond Sample Construction

This table shows the filters applied for constructing the brown bond sample.

	Number of bonds	Number of issuers
Initial Sample after duplicates and bonds without ISIN numbers are removed	1,402,375	1,582
Bonds issued after and equal to 2015	980,272	
Bonds with Plain Vanilla Fixed Coupon	343,113	
Bonds with principal currencies Euro, Dollar, Chinese Yuan, Japanese Yen, Swedish Krona, South Korean Yen	258,543	
Bonds issued by 1082 green issuers	172,199	856
Bonds issued by 744 green issuers	165,162	744
Bonds with Daily Total Returns	15,001	696
Bonds with Amount Issued (US) information	14,995	696
Bonds in the data set matched with benchmark bid yields	14,932	695
Bonds in the intersection	14,890	688
Bonds with at least 504 days of daily return data	3,375	162

In the final step of data collection, ESG Score and Environmental Pillar Score of the issuers were obtained from the TR based on the ISIN numbers of bonds. ESG scores were available for 105 green bonds and 1,042 brown bonds issued by 64 unique issuers.

When daily total returns, ESG Scores and Environmental Pillar Scores are merged to carry out the analysis, observations in years without ESG score information were dropped from the sample. 102 green bonds and 955 brown bonds of 62 unique issuers remained in the sample.

4.2. Methodology

4.2.1. Model Construction

Hypothesis 1: In the secondary market, the demand for corporate green bonds will be higher than the demand for the corporate brown bonds of the same issuers. The higher demand will be reflected in the total daily returns of bonds. In other words, green bonds will have higher total daily returns compared to brown bonds in the secondary market.

The dependent variable of the analysis is total daily returns of the corporate green bonds and corporate brown bonds. Government bond returns, coupon rate, maturity, callability and seniority were listed as the factors that affect corporate bond pricing by (Merton, 1974). From this point of view, daily bid yields of 10-year government bonds of the corresponding currencies Euro, Dollar, Chinese Yuan, Japanese Yen, Swedish Krona, South Korean Yen are included in the equation as an explanatory variable to account for the market wide changes during the observation period.

Bond characteristics callability, maturity, and seniority of the bonds are controlled with dummy variables. Coupon rates and natural logarithm of the issue amount in US dollars are included in the equation as other bond control variables to control the effect of bond characteristics on corporate bond yields in line with Bao et al., (2011). Moreover, the industry effect is controlled by the financial and utility dummies.

Hypothesis 2: Since the CBI certification may be associated with higher credibility and alleviate greenwashing concerns, the demand for CBI-Certified corporate green bonds will be higher than green bonds without CBI certification and brown bonds of the same issuers. Hence, corporate green bonds with CBI Certification will enjoy higher daily returns than green bonds without CBI certification and brown bonds of the same issuers.

Hypothesis 3: Since ESG ratings may be associated with higher credibility regarding a company's sustainability efforts, green bonds issued by companies with publicly available ESG ratings are expected to have higher daily total returns than green bonds issued by companies without ESG ratings. The higher demand will be evidenced by the higher daily total returns.

Hypotheses 1 through 3 are tested with Equation 1 given below.

$$\begin{aligned} Total\ Return_{it} = {} & \alpha_0 + \beta_0\, Green_i + \beta_1 CBI_i + \beta_2 ESG_i + \beta_3 GreenxESG_i + \alpha_1\, RF_t \\ & + \alpha_2\, CR_i + \alpha_3 \ln(AmountIssued_i) + \alpha_4\, Callable_i \\ & + \alpha_5\, LongTerm_i + \alpha_6\, MediumTerm_i + \alpha_7 Financial_i \\ & + \alpha_8 InvestmentGrade_i + \alpha_9 Utility_i + + \alpha_{10} USD_i \\ & + \alpha_{11} Yen_i + \alpha_{12} Krona_i + \alpha_{13} Yuan_i + \alpha_{14} Won_i + u_i \end{aligned} \quad (\mathbf{1})$$

In Hypothesis 3, it is claimed that green bonds issued by companies with the publicly available ESG ratings will enjoy higher returns in the secondary market. Whether the investors pay attention to the changes of the issuers' ESG scores or only the presence of an ESG score while buying a green bond is tested via Hypothesis 4.

Hypothesis 4: As the ESG Score of the company increases the green bond returns are expected to increase. Better ESG Scores should lead to higher green bond returns in the secondary market since higher ESG scores will signal the environmental friendliness of the company.

How issuers perceive ESG Scores is vague. Hence, rather than including ESG Scores directly in the analysis ESG Class variables are created. The range for ESG Scores is between 0 and 100. As a first alternative, a dummy variable is created which equals 1.0 for all issuers whose ESG Scores are greater than and equal to 85, and 0 otherwise. As a second alternative, a dummy variable is created which equals 1.0 for all issuers whose ESG Score is in top 10% of a given year, and 0 otherwise. Hypothesis 4 is tested with Equation 2 given below.

$$
\begin{aligned}
Total\ Return_{it} = {} & \alpha_0 + \beta_0\, Green_i + +\beta_2 ESG\ Class_{\ it} + \beta_3 Green\ xESG\ Class_{it} \quad (\mathbf{2}) \\
& +\alpha_1\ RF_t + \alpha_2\ CR_i + \alpha_3 \ln(AmountIssued_i) \\
& +\alpha_4\ Callable_i + \alpha_5\ LongTerm_i + \alpha_6\ MediumTerm_i \\
& +\alpha_7 Financial_i + \alpha_8 InvestmentGrade_i + \alpha_9 Utility_i \\
& + \alpha_{10} USD_i + \alpha_{11} Yen_i + \alpha_{12} Krona_i \\
& + \alpha_{13} Yuan_i + \alpha_{14} Won_i + u_i
\end{aligned}
$$

The ESG Score is calculated based on the environmental, social and governance scores of the companies. The environmental pillar score is more related to the green bond concept. Rather than the cumulative ESG score of the companies, the Environmental score may affect the green bond returns to a greater extent.

Hypothesis 5: As the Environmental Pillar Score of the company increases, the green bond returns are expected to increase.

Similar to the ESG Score, a class dummy variable is defined for Environmental Pillar Score. The range for the Environmental Pillar Score is also between 0 and 100. Two class specifications are defined. First, a dummy variable is created which equals 1.0 for all issuers whose ESG Scores are greater than and equal to 85, and 0 otherwise. Second, a dummy variable is created which equals 1.0 for all issuers whose ESG Score is in top 10% of a given year, and 0 otherwise.

Hypothesis 5 is tested with Equation 3 given below.

$$
\begin{aligned}
Total\ Return_{it} = {} & \alpha_0 + \beta_0\, Green_i + +\beta_2 EPS\ Class_{\ it} + \beta_3 Green\ xEPS\ Class_{it} \quad (\mathbf{3}) \\
& +\alpha_1\ RF_t + \alpha_2\ CR_i + \alpha_3 \ln(AmountIssued_i) \\
& +\alpha_4\ Callable_i + \alpha_5\ LongTerm_i + \alpha_6\ MediumTerm_i \\
& +\alpha_7 Financial_i + \alpha_8 InvestmentGrade_i + \alpha_9 Utility_i \\
& + \alpha_{10} USD_i + \alpha_{11} Yen_i + \alpha_{12} Krona_i \\
& + \alpha_{13} Yuan_i + \alpha_{14} Won_i + u_i
\end{aligned}
$$

World Health Organization (Who, 2020) characterized Covid-19 as a pandemic on March 11, 2020. The observation period of this study is from January 1, 2015 to December 31, 2021. Since the beginning of the Covid-19 pandemic is included in the sample period, the potential effects of the pandemic on bond returns and explanatory variables ESG Class and EPS Class are investigated. Based on the declaration of WHO, March 11, 2020 is selected as the cut off date. Equations 2 and 3 are re-estimated separately for the sub-periods that correspond to before and after the cut off day.

Variable definitions are given in Table 3.

Table 3: Variable Definitions

This table presents the definitions of variables used in various equations. Panel A presents the dependent variable. Panel B presents definitions of explanatory variables. Panel C presents the definitions of control variables.

Variable	Definition
	Panel A. Dependent Variable
Total Return	Daily Total Returns of bonds collected from Thomson Reuters
	Panel B. Explanatory Variables
Green	Dummy variable equals to 1 if the bond is labeled as Green by Thomson Reuters, 0 otherwise
CBI	Dummy variable equals to 1 if the bond is certified by Climate Bonds Initiative, 0 otherwise
ESG	Dummy variable equals to 1 if the bond issuer has ESG Score on Thomson Reuters database, 0 otherwise
Green x ESG	Interaction variable of green bond dummy variable and ESG dummy variable
ESG Class	ESG Score of the issuer company from 0 (worst) to 100 (best) collected from Thomson Reuters. Based on the class specification accepted as 1 or 0.
EPS Class	Environmental Pillar Score of the issuer company from 0 (worst) to 100 (best) collected from Thomson Reuters. Based on the class specification accepted as 1 or 0.
Green x ESG Class	Interaction variable of green bond dummy variable and ESG Class dummy variable
Green x EPS Class	Interaction variable of green bond dummy variable and EPS Class dummy variable

Table 3 – *Continued*

Panel C. Control Variables	
Market Variables	
RF	Benchmark risk free rate. 10-year bid yields of government bonds corresponding to the issue currency of the dependent variable
Bond Characteristics	
CR	Coupon rate of the bonds
ln(Amount Issued)	Natural logarithm of the issue amount of bonds in USD
Callable	Dummy variable equals to 1 if the bond is callable, 0 otherwise
Short Term	Dummy variable equals to 1 if the original time to maturity of the bond is shorter than 5 years, 0 otherwise (Base Dummy Variable)
Medium Term	Dummy variable equals to 1 if the original time to maturity of the bond is longer than 5 years and shorter than or equal to 10 years, 0 otherwise
Long Term	Dummy variable equals to 1 if the original time to maturity of the bond is longer than 10 years, 0 otherwise
Investment Grade	Dummy variable equals to 1 if the bond's rating is Investment Grade, 0 otherwise
Firm Control Variables	
Financial	Dummy variable equals to 1 if the issuer sector is one of the following: Banking, Financial - Other, Mortgage Banking, Real Estate Investment Trust, Life Insurance, Property and Casualty Insurance, 0 otherwise
Utility	Dummy variable equals to 1 if the issuer sector is one of the following: Utility – Other, Railroads, or Gas Utility – Local Distribution, and 0 otherwise
Others	Dummy variable equals to 1 if the issuer sector is neither financial, nor utility, 0 otherwise (Base Dummy Variable)
Currency of Denomination	
Euro	Dummy variable equals to 1 if the bond denominated in Euro, 0 otherwise (Base Dummy Variable)
USD	Dummy variable equals to 1 if the bond denominated in US Dollar, 0 otherwise
Yen	Dummy variable equals to 1 if the bond denominated in Japanese Yen, 0 otherwise
Krona	Dummy variable equals to 1 if the bond denominated in Swedish Krona, 0 otherwise
Yuan	Dummy variable equals to 1 if the bond denominated in Chinese Yuan, 0 otherwise
Won	Dummy variable equals to 1 if the bond denominated in Korean Won, 0 otherwise

4.2.2. Descriptive Statistics

The sample characteristics of the green and brown bonds used for estimating Equation 1 are provided in Table 4. On average, green bonds have shorter times to maturity, higher coupon rates, and higher issue amounts than brown bonds.

Table 4 : Green and Brown Bond Sample Characteristics Used for Estimating Equation 1

This table shows the sample characteristics of non-binary variables used for estimating Equation 1.

	Time To Maturity (in years)	Coupon Rate (%)	Amount Issued in USD (in millions)
Green Bond Sample			
Count	253	253	253
Mean	8.04	2.05	565.24
Std	4.89	1.80	337.54
Min	3.00	0.00	1.13
25%	5.01	0.63	341.07
50%	7.01	1.38	568.45
75%	10.01	3.25	700.00
Max	30.57	7.10	2,007.85
Brown Bond Sample			
Count	3,375	3,375	3,375
Mean	9.09	1.73	384.02
Std	5.45	1.34	626.29
Min	2.50	0.00	0.51
25%	5.35	0.83	28.29
50%	7.28	1.38	84.75
75%	10.01	2.28	565.65
Max	40.03	11.01	8,499.91

As shown in Table 5, 22 green bonds out of 253 have CBI certification. For the observation period between 2015 and 2021, the total number of daily observations of green bonds is 208,176 while that of brown bonds is 3,241,507.

Table 5 : Number of Daily Observations

This table illustrates the number of observations for the green, certified green and brown bonds.

	Green	CBI Certified Green	Brown
Number of Observations	208,176	18,060	3,241,507
Number of Bonds	253	22	3,375

The distribution of dummy variables is shown in Table 6. Number of bonds denominated in Euro outnumbers in both the brown and green bond samples. Almost one third of the green bonds are callable whereas callable bonds constitute less than 10% of the brown sample. 201 green bonds and 1,835 brown bonds are investment grade bonds. Medium term bonds dominate both samples.

Table 6 : Distribution of Binary Variables in the Sample Used for Estimating Equation 1

This table provides information regarding the distribution of control variables for the green and brown bonds in the sample.

	Green Bonds	*Brown Bonds*
Callable	73	284
Medium Term	164	1,889
Long Term	77	1,216
Investment Grade	201	1,835
Financial	153	2,900
Utility	40	235
US Dollar	62	520
Japanese Yen	9	164
Swedish Krona	9	47
Chinese Yuan	25	54
South Korean Won	7	340
CBI	22	-
ESG	105	1,042
Total # of Bonds	253	3,375

In Table 8, descriptive statistics of non-binary variables used for estimating Equation 1 are shown.

Table 7 : Descriptive Statistics of Non-Binary Variables in Equation 1

This table shows the descriptive statistics of non-binary variables used for estimating Equation 1.

	Daily Total Return (%)	10-year Benchmark Yields (%)	ln(Amount Issued in USD)	Coupon Rate (%)
Count	3,449,683	3,449,683	3,449,683	3,449,683
Mean	-0.09	0.41	19	1.78
Std	91.12	1.03	2	1.35
Min	-92,404.30	-0.84	13	0.00
25%	-0.07	-0.36	17	0.87
50%	0.01	0.03	19	1.39
75%	0.09	0.75	20	2.40
Max	455.87	4.07	23	11.01

Table 8 : Green and Brown Bond Sample Characteristics Used for Estimating Equations 2 and 3

This table shows the sample characteristics of non-binary variables used for estimating Equations 2 and 3.

	Time To Maturity (in year)	Coupon Rate (%)	Amount Issued in USD (in millions)
Green Bond Sample			
Count	102	102	102
Mean	7.67	1.38	622.94
Std	4.08	1.16	324.13
Min	3.03	0.00	52.52
25%	5.01	0.50	500.00
50%	7.01	1.00	568.45
75%	10.01	1.88	852.68
Max	30.02	4.63	1,705.36
Brown Bond Sample			
Count	955	955	955
Mean	10.00	2.04	784.00
Std	6.41	1.65	835.63
Min	2.81	0.00	0.76
25%	5.01	0.75	100.00
50%	10.00	1.50	565.85
75%	10.36	3.15	1,133.59
Max	40.03	11.01	8,499.91

Table 8 above shows the sample characteristics of green and brown bonds used in the estimation of Equations 2 and 3. This sample is a subset of the sample used for estimating Equation 1. After merging daily returns with the available ESG Scores and

Environmental Scores, 102 green bonds and 955 brown bonds of 62 unique issuers remained in the sample.

Table 9 : Descriptive Statistics of Non-Binary Variables Used for Estimating Equations 2 and 3

This table reports descriptive statistics of non-binary variables used in the estimation of Equations 2 and 3. The sample consists of daily observations of green and brown bonds. Daily bond returns are merged with the yearly ESG and Environmental Pillar Scores.

	Daily Total Return (%)	10-year Benchmark Yields (%)	ln(Amount Issued (USD))	Coupon Rate (%)	ESG Score (out of 100)	Environmental Pillar Score (out of 100)
Count	811,864	811,864	811,864	811,864	811,864	811,864
Mean	0.01	0.55	19.70	1.99	75.21	79.66
Std	1.00	1.08	1.63	1.56	12.80	14.83
Min	-72.98	-0.84	13.54	0.00	15.41	9.24
25%	-0.08	-0.31	18.54	0.77	68.76	74.30
50%	0.01	0.22	20.16	1.50	75.01	83.20
75%	0.12	0.88	20.85	3.00	85.42	89.22
Max	455.87	4.07	22.86	11.01	94.49	97.73

CHAPTER 5

RESULTS AND ANALYSIS

5.1. Panel Regression Results of Equation 1

The data set consists of unbalanced daily observations of brown and green bonds. Since STATA offers a variety of modules to handle different panel data characteristics, panel regressions were performed in STATA.

Before conducting the analysis, winsorizing was performed to eliminate the effect of outliers on the results. The dependent variable values lower than the 1st percentile and higher than the 99th percentile were trimmed. After that, specification tests were done to explore the characteristics of data. First, in order to show whether the data show panel data characteristics, the Breusch and Pagan Lagrange Multiplier Test was performed. Breusch and Pagan Lagrange Multiplier test's null hypothesis is that the variance of random effect is zero. If the null hypothesis is rejected, then it means that panel data regression models with random or fixed effects are more appropriate for the analysis. If not, pooled ordinary least square regression should be chosen for the analysis.

According to the test results shown in Table 10, the null hypothesis of Breusch and Pagan Lagrange Multiplier Test is rejected which means that fixed or random effect panel regression models should be chosen for the analysis.

Next, in order to choose between the fixed effect versus random effect panel data models, the Hausman test is carried out. The null hypothesis of Hausman test states that random effects are present in the model. Since the Hausman test result, as given

Table 10, is not significant, the null hypothesis is not rejected, and a random effects panel model is chosen for estimating Equation 1.

Table 10 : Diagnostics Tests for Equation 1

This table reports the results of diagnostics tests conducted to understand the characteristics of data for analysis of Equation 1. Breusch and Pagan Lagrange Multiplier test's null hypothesis is that the variance of random effect is zero. Since $p < 0.05$, the null hypothesis is rejected which means that the data set shows panel data characteristics. Next, to choose between the fixed versus random effect panel data model, the Hausman test is carried out. The null hypothesis of Hausman test states that random effects are present in the model. Since the p value > 0.05, the null hypothesis is not rejected, and therefore, a random effects panel model is chosen for the analysis of Equation 1. The null hypothesis of the Modified Wald test is that heteroscedasticity is not present in the model. Finally, the null hypothesis of the Wooldridge test is that there is no first-order auto correlation. Both null hypotheses are rejected. ** $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$*

	Chi Square Statistic
Breusch Pagan Lagrange Multiplier Test	1,144.23***
Hausman Test	1.05
Modified Wald Test	13,000,000***
	F Statistic
Wooldridge Test	140.68***

In the next step, Modified Wald and Wooldridge tests are performed for detecting heteroscedasticity and serial autocorrelation. The null hypothesis of the Modified Wald test states that the variance of error is the same for all panel members; in other words, heteroskedasticity is not present in the data. On the other hand, the null hypothesis of Wooldridge test states that there is no first-order autocorrelation. The test results are shown in Table 10. Since both null hypotheses are rejected, it is implied that the dataset suffers from heteroscedasticity and serial autocorrelation. To deal with these problems, the robust version of random effects model is chosen to estimate Equation 1.

It should be noted that, in order to capture the separate effects of the ESG and CBI dummies, the model in Equation 1 is estimated twice, once with each of the dummy variables. First, the CBI variable is excluded from Equation 1 and diagnostic tests are carried out. Test results are shown in Table 11. Based on the results, the robust version of the random effects panel data model is chosen.

Table 11 : Diagnostic Tests for Equation 1 without the CBI dummy variable

This table reports the results of diagnostics tests conducted to understand the characteristics of data for analysis of Equation 1 after removing the CBI dummy variable. Breusch and Pagan Lagrange Multiplier test's null hypothesis is that the variance of random effect is zero. Since p < 0.05, the null hypothesis is rejected which means that the data set shows panel data characteristics. Next, to choose between the fixed versus random effect panel data model, the Hausman test is carried out. The null hypothesis of Hausman test states that random effects are present in the model. Since the p value > 0.05, the null hypothesis is not rejected, and therefore, a random effects panel model is chosen for the analysis of Equation 1. The null hypothesis of the Modified Wald test is that heteroscedasticity is not present in the model. Finally, the null hypothesis of the Wooldridge test is that there is no first-order auto correlation. Both null hypotheses are rejected. * *p < 0.10, ** p < 0.05, *** p < 0.01*

	Chi Square Statistic
Breusch Pagan Lagrange Multiplier Test	1,144.29***
Hausman Test	1.05
Modified Wald Test	13,000,000***
	F Statistic
Wooldridge Test	140.68***

Second, the ESG variable and its interaction term with the green bond dummy are removed from Equation 1 and diagnostic tests are repeated. The test results are shown in Table12. Based on the results, a robust random effects panel regression model is chosen for analysis.

Table 12 : Diagnostic Tests for Equation 1 without ESG dummy variable

This table reports the results of diagnostics tests conducted to understand the characteristics of data for analysis of Equation 1 after removing the ESG variable from the equation. Breusch and Pagan Lagrange Multiplier test's null hypothesis is that the variance of random effect is zero. Since p < 0.05, the null hypothesis is rejected which means that the data set shows panel data characteristics. Next, to choose between the fixed versus random effect panel data model, the Hausman test is carried out. The null hypothesis of Hausman test states that random effects are present in the model. Since the p value > 0.05, the null hypothesis is not rejected, and therefore, a random effects panel model is chosen for the analysis of Equation 1. The null hypothesis of the Modified Wald test is that heteroscedasticity is not present in the model. Finally, the null hypothesis of the Wooldridge test is that there is no first-order auto correlation. Both null hypotheses are rejected. * *p < 0.10, ** p < 0.05, *** p < 0.01*

	Chi Square Statistic
Breusch Pagan Lagrange Multiplier Test	1,178.87***
Hausman Test	1.39
Modified Wald Test	13,000,000***
	F Statistic
Wooldridge Test	140.68***

Table 13 : Panel Regression Analysis for Equation 1

This table reports the estimation results for Equation 1. Column A shows the results when both of the ESG and CBI dummy variables are included in the model. Column B shows the results when the CBI dummy variable is excluded from the model. Panel C shows the results when the ESG dummy variable and its interaction term with the Green dummy variable are excluded from the equation. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Independent Variable	Column A. Regression Results for Equation 1	Column B. Regression Results for Equation 1 without the CBI dummy	Column C. Regression Results for Equation 1 without the ESG dummy
RF	-0.009***	-0.009***	-0.009***
	(0.000)	(0.000)	(0.000)
Green	0.002**	0.002**	0.002**
	(0.001)	(0.001)	(0.001)
ESG	0.002***	0.002***	
	(0.000)	(0.000)	
Green x ESG	0.001	0.001	
	(0.001)	(0.001)	
CBI	0.000		0.000
	(0.002)		(0.002)
CR	0.004***	0.004***	0.004***
	(0.001)	(0.001)	(0.001)
ln(Amount Issued in USD)	0.000*	0.000*	0.000***
	(0.000)	(0.000)	(0.000)
Callable	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)
Medium Term	0.003**	0.003**	0.003**
	(0.001)	(0.001)	(0.001)
Long Term	0.004***	0.004***	0.004***
	(0.001)	(0.001)	(0.001)
Investment Grade	0.001	0.001	0.001
	(0.000)	(0.000)	(0.000)
Financial	0.002*	0.002*	0.001
	(0.001)	(0.001)	(0.001)
Utility	-0.004***	-0.004***	-0.005***
	(0.001)	(0.001)	(0.001)
USD	0.015***	0.015***	0.015***
	(0.002)	(0.002)	(0.002)
Yen	-0.003***	-0.003***	-0.002***
	(0.001)	(0.001)	(0.001)
Krona	0.002*	0.002*	0.002*
	(0.001)	(0.001)	(0.001)
Yuan	0.030***	0.030***	0.030***
	(0.003)	(0.003)	(0.003)
Won	0.01***	0.01***	0.01***
	(0.001)	(0.001)	(0.001)
Intercept	-0.009***	-0.009***	-0.011***
	(0.003)	(0.003)	(0.003)
Number of observations	3,380,769	3,380,769	3,380,769
Number of bonds	3,628	3,628	3,628
Wald chi2	2817.500***	2815.800***	3028.940***

Table 13 above shows the results of random effects panel regression analysis for Equation 1.

The variables of interest in this analysis are Green, CBI, ESG, and Green x ESG. In line with expectations, corporate green bonds enjoy significantly higher returns than their brown counterparts. This result supports Hypothesis 1. Corporate green bonds are traded at 20 basis points higher daily returns compared to their brown counterparts in the secondary market. This can be explained by the increasing demand towards green bonds. Higher demand towards green bonds drive up the green bond prices and returns. There could be three possible reasons why investors are intrigued by green bonds.

First, investors who would like to be part of the transition towards a low-carbon economy can play their part by holding green bonds in their portfolios. This shift in the investors' mindset is directly reflected in the secondary market by higher demand and higher green bond returns. In other words, environmental preferences for the purpose of contributing to a more sustainable planet drive up the prices of green bonds.

Moreover, by investing in green bonds, investors may want to decrease their exposure to the environmental risks. Climate change related risks pose new challenges to businesses such as flood risk, increasing sea levels, forest fires, extreme temperatures, demographical migrations, and water scarcity. An informed investor who would like to mitigate the financial risks resulting from environmental risks may prefer holding green bonds in his/her portfolio since, based on the GBPs, the proceeds of green bonds are required to finance environmental projects that are aimed to deal with such possible problems. Hence, the need to hedge against climate-related risks is another possible explanation for the increasing demand for green bonds. Green bonds are issued to finance variety of projects such as renewable energy, protecting biodiversity, recycling, or carbon free transportation. By investing in green bonds investors have the freedom to choose among the green bonds that reflect their values best.

Finally, by holding green bonds rather than conventional bonds, investors can keep track of how their money is used. The reason is that green bond issuers are required to

provide reports to the investors justifying how and on which purposes they spend money raised from issuing green bonds. That is why enhancing reporting practices and creating universal green bond frameworks are essential to lure more investors and hence for the future of the green bond market.

Further results in Table 13 show that, contrary to expectations, CBI Certification does not have a significant impact on bond returns. If environmental preferences are the main driver of the green bond demand, then bonds with CBI certification are expected to have higher returns because they signal higher credibility. Generalizing this result may be misleading considering the number of CBI certified green bonds in the sample. Out of the 253 green bonds, only 22 bonds hold this certification. As the number of CBI certified green bonds increases, future studies can measure the effectiveness of certification more precisely. Another reason why the CBI effect is not significant may be that investors may consider the self-labeling of green bonds credible enough for investment. If this is the case, then obtaining certification would be an additional financial burden to the issuers due to the cost of the CBI certification. When the market does not respond positively to the CBI certification, there is no reason for issuers to bear the additional cost of certification. Instead, they can self-label their bonds as green. Moreover, this study examines secondary market returns; the effect of certification on green bond prices may be significant in the primary market.

Results in Table 13 also show that presence of a publicly available ESG rating for the issuer increases both green and brown bond returns by about 20 bps. However, the presence of an ESG rating does not add additional value to the green bonds.

5.2. Panel Regression Results of Equation 2

For the analysis of Equation 2, two ESG Class specifications are defined as explained in Chapter 4. First, the analysis is performed with the ESG Class definition of 85 points. When ESG Scores are greater than or equal to 85 points, the ESG Class variable is equal to 1, and 0 otherwise. The second analysis is performed based on the top 10% classification. If the issuer's ESG Score is in the top 10% for the corresponding year,

then the ESG Class dummy variable is equal to 1, and 0 otherwise. Before conducting the analysis, the data were winsorized in order to eliminate the effect of outliers on the results. The dependent variable values lower than the 1st percentile and higher than the 99th percentile were trimmed.

Next, to determine whether the data show panel characteristics, first the Breusch and Pagan Lagrange Multiplier Test is performed. According to the test results shown in Table 14, the null hypothesis is rejected which means that the dataset shows panel data characteristics. Afterwards, to choose between the fixed versus random effects panel data models, the Hausman test is carried out. Since the p value is smaller than 0.05, the null hypothesis is rejected and a fixed effects model is chosen.

Lastly, heteroscedasticity and serial correlation tests are carried out. The dataset has both heteroscedasticity and serial autocorrelation problems. The test results for the class 85 points specification are shown in Table 14.

Table 14 : Diagnostic Test Results for Equation 2 with Class Specification when ESG Score Greater than or Equal to 85 Points

This table reports the results of diagnostics tests conducted to understand the characteristics of data for estimating Equation 2. The ESG Class dummy variable equals 1 for scores greater than or equal to 85, and 0 otherwise. Breusch and Pagan Lagrange Multiplier test's null hypothesis is that the variance of random effect is zero. Since $p < 0.05$, the null hypothesis is rejected which means that the data set shows panel data characteristics. Next, to choose between the fixed versus random effect panel data model, the Hausman test is carried out. The null hypothesis of Hausman test states that random effects are present in the model. Since the p value < 0.05, the null hypothesis is rejected, and therefore, a fixed effects panel model is chosen for the analysis of Equation 1. The null hypothesis of the Modified Wald test is that heteroscedasticity is not present in the model. Finally, the null hypothesis of the Wooldridge test is that there is no first-order auto correlation. Both null hypotheses are rejected. ** $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$*

	Chi Square Statistic
Breusch Pagan Lagrange Multiplier Test	155.25***
Hausman Test	90.94***
Modified Wald Test	22,000,000***
	F Statistic
Wooldridge Test	75.02***

Fixed effects model controls for time-invariant characteristics such as dummy variables. Since the time-invariant variables or dummy variables are the same for bonds through time, the dummy variables are omitted because of collinearity when a

fixed effects panel regression is estimated. Since the variables of interest in this study are the dummy variables themselves, a fixed effects model is not suitable for estimating the model in Equation 2. To overcome these problems, instead of applying a fixed effects regression analysis, a linear regression with panel-corrected standard errors with the robust option (to deal with heteroscedasticity and autocorrelation) is chosen for the analysis. A linear regression with panel-corrected standard errors module is available on STATA with the xtpcse command. This command calculates estimations based on panel-corrected standard errors by assuming that disturbances are correlated across panels and they are heteroskedastic.

The same steps were followed for the ESG class specification of top 10%. Diagnostic test results are provided in Table 15. Based on the test results, a fixed effects model should be preferred rather than the random effects and the data suffer from heteroskedasticity and autocorrelation. However, as explained before, the fixed effect model is not suitable for this analysis and a linear regression with panel-corrected standard errors is chosen.

Table 15 : Diagnostics Test Results for Equation 2 with Class Specification when ESG Score is in top 10%

This table reports the results of diagnostics tests conducted to understand the characteristics of data for estimating Equation 2. The ESG Class dummy variable is equal to 1 for the top 10% of scores, and 0 otherwise. Breusch and Pagan Lagrange Multiplier test's null hypothesis is that the variance of random effect is zero. Since $p < 0.05$, the null hypothesis is rejected which means that the data set shows panel data characteristics. Next, to choose between the fixed versus random effect panel data model, the Hausman test is carried out. The null hypothesis of Hausman test states that random effects are present in the model. Since the p value < 0.05, the null hypothesis is rejected, and therefore, a fixed effects panel model is chosen for the analysis of Equation 1. The null hypothesis of the Modified Wald test is that heteroscedasticity is not present in the model. Finally, the null hypothesis of the Wooldridge test is that there is no first-order auto correlation. Both null hypotheses are rejected. ** $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$*

	Chi Square Statistic
Breusch Pagan Lagrange Multiplier Test	143.55***
Hausman Test	65.92***
Modified Wald Test	22000000***
	F Statistic
Wooldridge Test	75.02***

The estimation results of both class specifications are given in Table 16.

Table 16 : Regression Analysis Results for Equation 2

This table reports the estimation results for Equation 2. Column A shows the results when the ESG Score Class dummy variable is equal to 1 for ESG Scores greater than 85, and 0 otherwise. Column B shows the results when the ESG Score Class dummy variable is equal to 1 ESG Scores in the top 10% for the corresponding year, and 0 otherwise. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Independent Variable	Column A. Regression Results when ESG Score > 85 points	Column B. Regression Results when ESG Score is in the top 10%
RF	-0.013*	-0.013*
	(0.007)	(0.007)
Green	0.006***	0.007***
	(0.001)	(0.001)
ESG Class	-0.001	0.003
	(0.002)	(0.002)
Green x ESG Class	-0.004*	-0.009***
	(0.002)	(0.003)
CR	0.003**	0.003**
	(0.001)	(0.001)
ln(Amount Issued in USD)	0.001*	0.001*
	(0.001)	(0.001)
Callable	0.003***	0.006***
	(0.002)	(0.002)
Medium Term	0.005*	0.004*
	(0.002)	(0.002)
Long Term	0.014***	0.014**
	(0.005)	(0.005)
Investment Grade	0.001	0.001
	(0.000)	(0.000)
Financial	0.002	0.002
	(0.002)	(0.002)
Utility	-0.005*	-0.004
	(0.003)	(0.003)
USD	0.024	0.025
	-0.015	-0.015
Yen	-0.010**	-0.010**
	(0.005)	(0.005)
Krona	0.000	0.000
	(0.004)	(0.004)
Yuan	0.042*	0.043*
	(0.024)	(0.024)
Won	0.019	0.019
	(0.015)	(0.015)
Intercept	-0.020*	-0.020*
	(0.010)	(0.010)
Number of observations	795,629	795,629
Number of bonds	1,057	1,057
Wald chi2	96.75***	97.34***
	Chi Square Statistic	Chi Square Statistic
(Green x ESG Class + Green = 0)[1]	0.75	1.01

[1] T Test is conducted to test if the sum of the ESG Class and ESG Class x Green coefficients is significantly different from zero.

The variables of interests are coefficients of Green, ESG Class, and Green x ESG Class. The panel regression results given in Table 16 provide evidence for the existence of a green premium. However, the relationship between the ESG Class dummy variable and bond returns is not statistically significant. Considering the results of Equation 1 where the presence of a publicly available ESG Score increases both green and brown bond returns, this result is surprising. It seems that investors do not pay attention to the actual value of the ESG score, only to the fact that the issuer has an ESG rating. On the other hand, generalizing these results might be misleading sine the definition of class is subjective. Results could have been different under different class assumptions.

In this study, the ESG Scores are collected from the TR database. It is important to keep in mind that measuring companies' ESG performances are also subject to the evaluation criteria of TR. It would be meaningful to repeat this study with ESG Scores collected from different sources such as MSCI and Bloomberg for future studies.

The coefficient of the interaction term Green x ESG Class is negative and significant under both ESG Class specifications. This implies that the return advantage of a green bond compared to a brown bond is lower when the issuer has a high ESG score. Furthermore, the sum of the Green dummy and the interaction term coefficients is not significantly different from zero, as shown in the last row of Table 16. This result suggests that the return advantage of a green bond disappears when the issuer has a relatively high ESG rating. This finding may also suggest that investors seem to care more about the ESG reputation of the companies rather than the use of bond proceeds. This result may point to the importance of reputation for green bonds. Improved standardization frameworks and enhanced reporting practices may help to increase the relative advantage of green bonds.

In this study, the sample period is between 2015 and 2021. Since the beginning of pandemic is included during the period, Equation 2 is estimated again separately for the before- and after-pandemic periods. Table 17 shows the diagnostics test results before and after the pandemic for the two ESG Class definitions. According to Table 17, a panel-corrected standard errors linear regression estimation is used when the ESG

Class variable is defined based on the 85-point cutoff, and a robust random effects model is used for the other cases.

Table 17: Diagnostic Test Results for Equation 2 with Class Specifications Before and After Pandemic

This table reports the results of diagnostics tests conducted to understand the characteristics of data for estimating Equation 2 before and after the pandemic under two different ESG class definitions. Column A reports the test result before the pandemic when ESG Class is defined based on 85 points. Column B shows the test results after the pandemic when ESG Class is defined based on 85 points. Columns C and D show the estimation results before and after the pandemic, respectively, when ESG Class is defined based on the top 10% for each year. Breusch and Pagan Lagrange Multiplier test's null hypothesis is that the variance of random effect is zero. Since $p < 0.05$, the null hypothesis is rejected which means that the data set shows panel data characteristics. Next, to choose between the fixed versus random effect panel data model, the Hausman test is carried out. The null hypothesis of Hausman test states that random effects are present in the model. Since the p value < 0.05, the null hypothesis is rejected, and therefore, a fixed effects panel model is chosen for the analysis of Equation 2. The null hypothesis of the Modified Wald test is that heteroscedasticity is not present in the model. Finally, the null hypothesis of the Wooldridge test is that there is no first-order auto correlation. Both null hypotheses are rejected. ** $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$*

Tests	Column A. Diagnostics Test Results for Equation 2 with class specification 85 points before pandemic	Column B. Diagnostics Test Results for Equation 2 with class specification 85 points after pandemic	Column C. Diagnostics Test Results for Equation 2 with class specification top 10% before pandemic	Column D. Diagnostics Test Results for Equation 2 with class specification top 10% after pandemic
	Chi Square Statistic	Chi Square Statistic	Chi Square Statistic	Chi Square Statistic
Breusch Pagan Lagrange Multiplier Test	74.05***	13.16***	60.51***	63.83***
Hausman Test	8.38**	6.08	6.39	5.63
Modified Wald Test	12,000,000***	52,000,000***	15,000,000***	24,000,000***
	F Statistic	F Statistic	F Statistic	F Statistic
Wooldridge Test	113.49***	48.35***	64.30***	65.60***

Table 18 : Panel Regression Analysis Results for Equation 2 After and Before Pandemic

This table reports the results of panel regression estimation for Equation 2 before and after the pandemic. Column A shows the results when ESG Score Class dummy variable is defined based on 85 points. Column B shows the results when ESG Score Class dummy variable is defined based on top 10%. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

	Column A. Regression Results for Equation 2 with class specification when ESG Score > 85 points		Column B. Regression Results for Equation 2 with class specification when ESG Score is in top 10%	
Independent Variable	Before Pandemic	After Pandemic	Before Pandemic	After Pandemic
RF	-0.028**	-0.077***	-0.030**	-0.069***
	(0.012)	(0.005)	(0.013)	(0.005)
Green	0.003**	0.009***	0.003*	0.011***
	(0.002)	(0.003)	(0.002)	(0.003)
ESG Class	0.000	0.004*	0.002	0.007**
	(0.002)	(0.002)	(0.002)	(0.003)
Green x ESG Class	-0.005*	-0.004	-0.006	-0.014**
	(0.003)	(0.006)	(0.004)	(0.007)
CR	0.002*	0.004**	0.002	0.002
	(0.001)	(0.002)	(0.002)	(0.002)
ln(Amount Issued in USD)	0.000	0.003***	0.000	0.002***
	(0.001)	(0.001)	(0.001)	(0.001)
Callable	0.004*	0.008***	0.004**	0.006*
	(0.002)	(0.004)	(0.002)	(0.004)
Medium Term	0.007**	0.003	0.008**	0.006
	(0.001)	(0.002)	(0.003)	(0.003)
Long Term	0.018***	0.007**	0.020***	0.010***
	(0.006)	(0.003)	(0.006)	(0.003)
Investment Grade	0.002	-0.004	0.002	-0.001
	(0.001)	(0.003)	(0.001)	(0.003)
Financial	-0.001	0.011***	-0.001	0.008***
	(0.002)	(0.003)	(0.002)	(0.003)
Utility	-0.001	-0.008	-0.005	-0.005
	(0.003)	(0.005)	(0.003)	(0.004)
USD	0.068**	0.091***	0.071**	0.084***
	(0.029)	(0.008)	(0.030)	(0.008)
Yen	-0.012**	0.024***	-0.012**	0.017***
	(0.006)	(0.004)	(0.006)	(0.004)
Krona	0.003	0.034***	0.003	0.026***
	(0.005)	(0.007)	(0.005)	(0.005)
Yuan	0.103***	0.254***	0.108***	0.229***
	(0.039)	(0.018)	(0.041)	(0.018)
Won	0.053**	0.135***	0.056**	0.121***
	(0.025)	(0.011)	(0.026)	(0.010)
Intercept	-0.004	-0.089***	-0.002	-0.079***
	(0.011)	(0.013)	(0.012)	(0.010)
Number of observations	559,414	236,215	559,414	236,215
Number of bonds	1,057	1,057	1,057	1,057
Wald chi2	101.12***	583.81***	98.88***	640.44***
	Chi^2 Statistics			Chi^2 Statistics
(Green x ESG Class + Green = 0)[1]	0.60			0.34

Table 18 shows the results of panel regression analysis for before and after pandemic periods. Green bond premium has increased after the pandemic under both ESG Class scenarios. This result supports the recent studies about the effects of Covid 19 pandemic on green bond returns (Yi et al., 2021; Guo & Zhou, 2021; Hacıömeroğlu et al., 2021). The pandemic has exposed the fragility of economic, political, and social systems. It exacerbated the existing humanitarian problems. Some people not only lost their health but also their jobs. On the positive side, as each crisis comes up with an opportunity, some lessons have been learned. After the pandemic has struck, investors' perception of environmental awareness and climate crises has changed.

While the analysis of whole sample and before the pandemic do not reveal any significant relationship between ESG class and bond returns, after the pandemic the impact of the ESG class variable on bond returns is significant and positive. Not only green bonds but also brown bonds of the companies with high ESG scores enjoyed higher returns due to higher demands. This inference supports the investors' choice of making good. It also supports the earlier finding that, after an increase in the awareness of the climate crisis, investors want to hedge themselves against environment-related financial risks by holding bonds issued by high ESG rating companies in their portfolio.

The other variable of interest is the interaction term Green x ESG Class. The coefficient of the interaction term is always negative but not always significant. That is why the results does not reveal a robust relationship between ESG Scores and green bond returns. Furthermore, the sum of the Green dummy and the interaction term coefficients is not significant. As before, the return advantage of a green bond disappears when the issuer has a high ESG rating.

5.3. Panel Regression Results of Equation 3

Equation 3 is estimated by using two Environmental Pillar Score (EPS) Class specifications instead of the ESG Class variables. First, the analysis is performed with the EPS Class dummy that is equal to 1 when the EPS is greater than or equal to 85 points, and 0 otherwise. Second, the analysis is repeated with the alternative EPS Class dummy that is equal to 1 when the EPS of the issuer is in the top 10% of EPS for a given year, and 0 otherwise. Before conducting the analysis, the data are winsorized in order to eliminate the effect of outliers on the results. The dependent variable values lower than the 1st percentile and higher than the 99th percentile were trimmed.

Next, to determine whether the data show panel characteristics, the Breusch and Pagan Lagrange Multiplier Test is conducted. According to the test results shown in Table 19, the null hypothesis is rejected which means that the dataset shows panel data characteristics. Next, to choose between the fixed versus and random effects panel data models, the Hausman test is carried out. Since the result is significant, the null hypothesis is rejected, implying that a fixed effect model should be used. Finally, heteroscedasticity and serial correlation tests are carried out. The model suffers from both heteroscedasticity and serial autocorrelation.

As explained above for the ESG Class models, a fixed effects model is not appropriate for estimating Equation 3 since the model has dummy variables that would be ultimately omitted by the model. As a result, a linear regression with panel-corrected standard errors is used for estimating Equation 3 when the EPS class is defined based on 85 points.

Table 19 : Diagnostic Test Results for Equation 3 with Class Specification When Environmental Pillar Score is ≥ 85 points

This table reports the results of diagnostics tests conducted to understand the characteristics of data for estimating Equation 3. The Environmental Pillar Score Class dummy variable equals 1 when the Environmental Pillar Score ≥ 85 points, and 0 otherwise. Breusch and Pagan Lagrange Multiplier test's null hypothesis is that the variance of random effect is zero. Since $p < 0.05$, the null hypothesis is rejected which means that the data set shows panel data characteristics. Next, to choose between the fixed versus random effect panel data model, the Hausman test is carried out. The null hypothesis of Hausman test states that random effects are present in the model. Since the p value < 0.05, the null hypothesis is rejected, and therefore, a fixed effects panel model is chosen for the analysis of Equation 3. The null hypothesis of the Modified Wald test is that heteroscedasticity is not present in the model. Finally, the null hypothesis of the Wooldridge test is that there is no first-order auto correlation. Both null hypotheses are rejected. ** $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$*

	Chi Square Statistic
Breusch Pagan Lagrange Multiplier Test	155.25***
Hausman Test	90.94***
Modified Wald Test	22,000,000***
	F Statistic
Wooldridge Test	75.02***

Diagnostic test results are provided in Table 20 for the class specification of top 10%. Based on the test results, a fixed effect model should be preferred rather than the random effect model for estimating Equation 3 and data suffer from heteroskedasticity and autocorrelation. However, as explained before, the fixed effects model is not suitable for this analysis and a linear regression with panel-corrected standard errors is used instead.

Table 20 : Diagnostic Test Results for Equation 3 with Class Specification When Environmental Pillar Score is in Top 10%

This table reports the results of diagnostics tests conducted to understand the characteristics of data for analysis of Equation 3. The Environmental Pillar Score Class dummy variable equals 1 when the Environmental Pillar Score is in the top 10% for a given year. Breusch and Pagan Lagrange Multiplier test's null hypothesis is that the variance of random effect is zero. Since $p < 0.05$, the null hypothesis is rejected which means that the data set shows panel data characteristics. Next, to choose between the fixed versus random effect panel data model, the Hausman test is carried out. The null hypothesis of Hausman test states that random effects are present in the model. Since the p value < 0.05, the null hypothesis is rejected, and therefore, a fixed effects panel model is chosen for the analysis of Equation 1. The null hypothesis of the Modified Wald test is that heteroscedasticity is not present in the model. Finally, the null hypothesis of the Wooldridge test is that there is no first-order auto correlation. Both null hypotheses are rejected. ** $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$*

	Chi Square Statistics
Breusch Pagan Lagrange Multiplier Test	149.88***
Hausman Test	61.54***
Modified Wald Test	22,000,000***
	F Statistics
Wooldridge Test	75.02***

Table 21: Panel Regression Analysis Results for Equation 3

This table reports the results of panel regression estimation for Equation 3. Column A shows the results when the Environmental Pillar Score Class dummy variable is equal to 1 when the Environmental Pillar Score is greater than 85, and 0 otherwise. Column B shows the results when the Environmental Pillar Score Class dummy variable is equal to 1 when the Environmental Pillar Score is in the top 10% for the corresponding year, and 0 otherwise. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Independent Variable	Column A. Regression Results for Equation 3 with class specification when Environmental Pillar Score ≥ 85 points	Column B. Regression Results for Equation 3 with class specification when Environmental Pillar Score is in top 10%
RF	-0.013*	-0.013*
	(0.007)	(0.007)
Green	0.006***	0.006***
	(0.002)	(0.002)
EPS Class	0.005***	0.000
	(0.001)	(0.002)
Green x EPS Class	0.001	0.004
	(0.002)	(0.003)
CR	0.003**	0.003**
	(0.001)	(0.001)
ln(Amount Issued in USD)	0.001*	0.001*
	(0.000)	(0.001)
Callable	0.005***	0.006***
	(0.002)	(0.002)
Medium Term	0.005*	0.004*
	(0.002)	(0.002)
Long Term	0.015***	0.014**
	(0.005)	(0.005)
Investment Grade	0.008	0.001
	(0.000)	(0.000)
Financial	0.000	0.002
	(0.002)	(0.002)
Utility	-0.004	-0.004
	(0.003)	(0.003)
USD	0.026*	0.024
	(0.015)	(0.015)
Yen	-0.009*	-0.010**
	(0.005)	(0.005)
Krona	0.000	0.000
	(0.004)	(0.004)
Yuan	0.045*	0.042*
	(0.024)	(0.024)
Won	0.021	0.019
	(0.015)	(0.015)
Intercept	-0.021*	-0.020*
	(0.015)	(0.010)
Number of observations	795,629	795,629
Number of bonds	1,057	1,057
Wald chi^2	102.62***	106.19***

Table 21 shows the estimation results for Equation 3. Contrary to expectations, higher Environmental Pillar Scores do not lead higher green bond returns. This implies that higher Environmental Pillar Scores do not necessarily matter for the green bond investors. This is surprising though since green bond proceeds are tied up to finance environment-friendly projects and companies with better environment pillar scores are expected to lure investors by alleviating green washing concerns. While ESG Scores increase returns of green and brown bonds under both class scenarios, the EPS class does not make any significant contribution to the bond returns when it is defined based on top 10% score holders. It is evident that investors take composite ESG scores into account rather than sole Environmental Pillar Scores. It is possible that the ESG rating may receive greater publicity and investors may not be familiar with the individual components that make up the composite ESG rating. Also, similar to the discussions of ESG Class, the results of the analysis are contingent upon the class definitions.

The sample period is divided into before and after the pandemic periods and analysis is performed separately for each subperiod. Panel specific test results are shown in Table 22. According to the test results, Equation 3 is estimated by using panel-corrected standard errors linear regression when the EPS Class is defined based on 85 points and for the before pandemic period. For the other three cases, robust random effects model is used.

Table 22 : Diagnostic Test Results for Equation 3 with EPS Class Specifications Before and After Pandemic

This table reports the results of diagnostics tests conducted to understand the characteristics of data for estimating Equation 3 before and after the pandemic under two different EPS class definitions. Column A reports the test result before the pandemic when EPS Class is defined based on 85 points. Column B shows the test results after the pandemic when EPS Class is defined based on 85 points. Column C and Column D show the results of tests respectively before and after the pandemic when EPS Class is defined based on top 10% for each year. Breusch and Pagan Lagrange Multiplier test's null hypothesis is that the variance of random effect is zero. Since $p < 0.05$, the null hypothesis is rejected which means that the data set shows panel data characteristics. Next, to choose between the fixed versus random effect panel data model, the Hausman test is carried out. The null hypothesis of Hausman test states that random effects are present in the model. Since the p value < 0.05, the null hypothesis is rejected in Column A, and therefore, a fixed effects panel model is chosen for the analysis of Equation 3. The null hypothesis for the Hausman test is not rejected in the other columns, implying the use a random effects model. The null hypothesis of the Modified Wald test is that heteroscedasticity is not present in the model. Finally, the null hypothesis of the Wooldridge test is that there is no first-order auto correlation. Both null hypotheses are rejected. ** p < 0.10, ** p < 0.05, *** p < 0.01*

Tests	Column A. Diagnostics Test Results with class specification 85 points before pandemic	Column B. Diagnostics Test Results with class specification 85 points after pandemic	Column C. Diagnostics Test Results with class specification top 10% before pandemic	Column D. Diagnostics Test Results with class specification top 10% after pandemic
	Chi Square Statistic	Chi Square Statistic	Chi Square Statistic	Chi Square Statistic
Breusch Pagan Lagrange Multiplier Test	70.81***	11.58***	58.12***	67.04***
Hausman Test	26.93***	1.45	7.66	5.49
Modified Wald Test	12,000,000***	52,000,000***	15,000,000***	24,000,000***
	F Statistic	F Statistic	F Statistic	F Statistic
Wooldridge Test	113.491***	48.35***	64.3***	65.59***

The panel regression analysis results of Equation 3 before and after the pandemic are given in Table 23. Although the green premium is significant when the model is estimated over the whole sample period, the green dummy is not significant before the pandemic. Moreover, the EPS Class coefficients are significant and positive after the pandemic. It is evident that after the pandemic, companies with higher environmental pillar scores enjoyed higher returns both in their green bonds and brown bonds. Similar to the result of whole sample, the EPS Class does not have any significant relationship with the green bond returns before and after the pandemic.

Table 23 : Panel Regression Results for Equation 3 Before and After the Pandemic

This table reports the results of panel regression estimation for Equation 3 before and after the pandemic. Column A shows the results when the Environmental Pillar Score Class dummy variable is equal to 1 when the Environmental Pillar Score is greater than 85, and 0 otherwise. Column B shows the results when the Environmental Pillar Score Class dummy variable is equal to 1 when the Environmental Pillar Score is in the top 10% for the corresponding year, and 0 otherwise. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

	Column A. Regression Results with class specification when Environmental Pillar Score ≥ 85 points		Column B. Regression Results with class specification when Environmental Pillar Score is in top 10%	
Independent Variable	Before Pandemic	After Pandemic	Before Pandemic	After Pandemic
RF	-0.030**	-0.068***	-0.030***	-0.069***
	(0.013)	(0.005)	(0.001)	(0.004)
Green	0.001	0.010***	0.001	0.011***
	(0.002)	(0.003)	(0.002)	(0.003)
EPS Class	0.001	0.004**	0.001	0.004*
	(0.002)	(0.002)	(0.001)	(0.002)
EPS Class x Green	0.004	0.000	0.002	-0.007
	(0.002)	(0.005)	(0.007)	(0.007)
CR	0.002	0.002	0.002	0.002
	(0.002)	(0.002)	(0.001)	(0.002)
ln(Amount Issued in USD)	0.000	0.002***	0.000	0.002***
	(0.001)	(0.001)	(0.001)	(0.001)
Callable	0.004**	0.006*	0.003	0.006*
	(0.002)	(0.004)	(0.002)	(0.004)
Medium Term	0.008***	0.006**	0.009***	0.006**
	(0.003)	(0.001)	(0.002)	(0.003)
Long Term	0.020***	0.010***	0.023***	0.010***
	(0.006)	(0.003)	(0.002)	(0.004)
Investment Grade	0.002	-0.001	0.003**	0.000
	(0.002)	(0.003)	(0.001)	(0.003)
Financial	-0.002	0.007***	-0.001	0.007***
	(0.002)	(0.003)	(0.001)	(0.003)
Utility	-0.005	-0.006	-0.005**	-0.006
	(0.003)	(0.004)	(0.002)	(0.004)
USD	0.071**	0.082***	0.074**	0.083***
	(0.002)	(0.008)	(0.002)	(0.008)
Yen	-0.012*	0.017***	-0.012***	0.017***
	(0.006)	(0.004)	(0.002)	(0.004)
Krona	0.003	0.026***	0.004**	0.026***
	(0.005)	(0.004)	(0.002)	(0.005)
Yuan	0.108***	0.225***	0.111***	0.229***
	(0.041)	(0.017)	(0.006)	(0.018)
Won	0.056**	0.120***	0.058***	0.121***
	(0.026)	(0.010)	(0.004)	(0.010)
Intercept	-0.002	-0.080***	-0.005	-0.079***
	(0.012)	(0.012)	(0.007)	(0.012)
Number of observations	559,414	236,215	559,414	236,215
Number of bonds	1,057	1,057	1,057	1,057
Wald chi2	103.57***	653.47***	1789.48***	650.31***

CHAPTER 6

CONCLUSION

Although researchers have been trying to explain the prices of financial instruments by using models and predefined equations for decades, there is one unadulterated truth humans are the primary components of finance. As a direct consequence, preferences shape the prices. In this thesis, the daily total returns of green and brown bonds issued by the same issuers have been compared. It is found that investors have an incentive to invest in green bonds and this demand is reflected in green bond returns. When the effect of CBI certification on green bond returns is analyzed, there is no evidence of a a significant impact. The drawback of this study is the number of CBI certified green bonds in the sample. As the number of CBI certified green bonds increases over time, it may be possible to capture the effects of certification on green bond returns.

The study also examines whether the presence of an ESG rating for the bond issuer has any impact on green and brown bond returns. The results indicate that the presence of a publicly available ESG ratings for the issuing company adds value to both green and brown bonds and increases the returns. However, the presence of a publicly available ESG rating does not have additional significant impact on green bond returns.

The extent to which an increase in the ESG Score or one of its components, the Environmental Pillar Score, affects the green and brown bond returns is also analyzed. Results imply that the return advantage of green bonds disappears when the issuer has a high ESG or EPS score, since brown bond returns are also higher when the ESG or EPS rating is high.

The effect of the pandemic is also analyzed since the sample period of the study is between 2015 and 2021. Results show that significantly higher green bond returns are observed after the pandemic.

This study contributes to the growing green bond literature since it fills a gap by addressing the effect of not only the CBI certification but also the issuer's ESG/EPS rating on green bond returns.

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APPENDICES

A. SPEARMAN'S CORRELATION FOR THE CONTINUES VARIABLES OF EQUATION 1

This table reports the Spearman's Correlation Analysis for the Continues Variables of Equation 1. *** Correlation is significant at 0.001 level.

	Variables		
	RF	Coupon	ln(Amount Issued in USD)
RF	1		
Coupon	0.5528***	1	
ln(Amount Issued in USD)	0.1911***	0.0836***	1

B. SPEARMAN'S CORRELATION FOR THE CONTINUES VARIABLES OF EQUATION 2 AND 3

This table reports the Spearman's Correlation Analysis for the Continues Variables of Equation 2 and 3. *** Correlation is significant at 0.001 level.

	Variables		
	RF	Coupon	ln(Amount Issued in USD)
RF	1		
Coupon	0.6118***	1	
ln(Amount Issued in USD)	0.194***	0.1411***	1

C. PEARSON'S CORRELATION FOR THE DUMMY VARIABLES OF EQUATION 1

This table reports the Pearson's Correlation Analysis for the Dummy Variables of Equation 1. * Correlation is significant at 0.05 level

	Variables													
	green	cbi	callable	medium	long	investment	financial	utility	usdollar	yen	krona	yuan	won	esg
green	1													
cbi	0.286*	1												
callable	0.166*	-0.005*	1											
medium	0.046*	0.038*	-0.169*	1										
long	-0.036*	-0.037*	0.193*	-0.887*	1									
investment	0.124*	0.063*	0.218*	-0.211*	0.262*	1								
financial	-0.161*	0.011*	-0.362*	0.124*	-0.152*	0.015*	1							
utility	0.086*	-0.005*	0.151*	-0.087*	0.105*	-0.096*	-0.650*	1						
usdollar	0.057*	0.014*	0.228*	-0.169*	0.171*	0.285*	-0.177*	0.049*	1					
yen	-0.020*	-0.016*	-0.071*	-0.063*	0.084*	-0.072*	-0.073*	-0.062*	-0.097*	1				
krona	0.045*	0.016*	-0.038*	-0.029*	0.000*	0.092*	0.026*	-0.026*	-0.052*	-0.026*	1			
yuan	0.132*	-0.010*	-0.029*	0.084*	-0.069*	-0.112*	-0.051*	0.030*	-0.060*	-0.030*	-0.016*	1		
won	-0.063*	-0.023*	-0.097*	-0.071*	0.016*	-0.361*	-0.342*	0.465*	-0.137*	-0.068*	-0.037*	-0.043*	1	
esg	0.058*	0.037*	0.096*	-0.146*	0.161*	0.308*	-0.278*	0.086*	0.213*	0.154*	0.000*	-0.041*	-0.040*	1

D. PEARSON'S CORRELATION FOR THE DUMMY VARIABLES OF EQUATION 2 AND 3

This table reports the Pearson's Correlation Analysis for the Dummy Variables of Equation 2 and 3. All Coefficients are significant at 0.05 level

	Variables																
	green	cbi	callable	medium	long	investment	Financial	utility	us dollar	yen	krona	yuan	won	Esg class10	esg85	Eps class10	eps85
green	1																
cbi	0.342	1															
callable	0.123	-0.040	1														
medium	0.168	0.087	-0.068	1													
long	-0.161	-0.092	0.080	-0.919	1												
investment	0.006	0.043	0.101	0.011	0.020	1											
financial	-0.162	0.044	-0.469	0.003	-0.021	0.077	1										
utility	0.141	-0.020	0.181	0.020	-0.017	0.072	-0.341	1									
usdollar	-0.084	-0.036	0.094	-0.087	0.072	0.144	-0.051	-0.087	1								
yen	-0.040	-0.037	-0.146	-0.056	0.073	-0.493	-0.117	-0.075	-0.239	1							
krona	0.031	-0.012	-0.045	0.030	-0.103	0.040	0.022	-0.023	-0.074	-0.042	1						
yuan	0.002	-0.011	-0.044	0.128	-0.117	-0.028	0.066	-0.023	-0.072	-0.041	-0.013	1					
won	-0.024	-0.008	-0.032	0.042	-0.049	-0.188	-0.135	-0.016	-0.052	-0.030	-0.009	-0.009	1				
esgclass10	-0.062	-0.042	-0.031	-0.060	0.083	0.106	0.153	-0.057	-0.030	-0.075	0.009	-0.009	-0.034	1			
esg85	-0.077	-0.020	-0.068	-0.043	0.054	0.138	0.224	-0.061	-0.052	-0.115	0.023	-0.007	-0.047	0.723	1		
epsclass10	-0.039	-0.025	0.001	0.010	-0.018	0.025	0.150	-0.086	-0.009	-0.065	0.022	0.005	-0.034	0.534	0.565	1	
eps85	-0.076	0.034	-0.105	0.015	-0.027	0.084	0.322	-0.084	-0.133	-0.114	-0.003	-0.044	-0.069	0.284	0.375	0.441	1

E. TURKISH SUMMARY / TÜRKÇE ÖZET

Sürdürülebilir finans klasik bağış anlayışıyla finansal kazanımları ortak bir paydada buluşturur. Yeşil finans sürdürülebilir finansın bir alt başlığıdır. Yeşil finansın esas ilgilendiği konular küresel ısınmayla mücadele, küresel ısınmanın etkilerinin azaltılması, ve diğer çevre ile ilgili konularken sürdürülebilir finans daha geniş bir çatı altında sosyal, çevresel ve yönetişimsel konuları da içerir.

Yeşil finansın son yıllarda en çok talep gören finansal yatırım aracı olan yeşil tahviller piyasayla ilk tanıştığı yıl olan 2007'den günümüze hızlı bir büyüme kaydetmiştir. 2007 yılında Avrupa Yatırım Bankası'nın İklim Farkındalığı Tahvili ile finans dünyası yeni bir tahvil türüyle tanışmış oldu. Normal tahvillerden farklı olarak yeşil tahvillerden elde edilen finansman iklim, çevre, temiz enerji kaynakları, karbonsuz ulaşım, biyolojik tür çeşitliliğinin korunması gibi belli başlı projelerde kullanılır (Green Bond Principles, 2018). Yeşil tahviller iklim kriziyle mücadele önemli bir kalkınma aracıdır. Yeşil tahviller, borsada işlem gören diğer menkul kıymetlerle aynı mali düzenlemelere tabidir. Yeşil tahvilleri normal tahvillerden ayıran şey, gelirlerin amaçlanan kullanımıdır.

2021 yılının üçüncü çeyreğinde kümülatif yeşil tahvil piyasası hacmi 1,4 trilyon dolara ulaşmıştır (CBI, 2021). 2013 yılına kadar Dünya Bankası ve Avrupa Yatırım Bankası gibi Kalkınma Bankaları yeşil tahvil ihraç eden tek kuruluşlardı. Kasım 2013'te, bir İskandinav emlak şirketi olan Vasakronan, dünyanın ilk kurumsal yeşil tahvilini çıkardı (Vasakronan Green Bond Framework, 2017). Bu yıl yeşil tahvil piyasası için dönüm noktası oldu. Diğer büyük şirketler Vasakronan örneğini izledi. Örneğin, Mart 2014'te Unilever 250 milyon sterlinlik yeşil tahvil ihraç etti. Şirketin amacı, yeşil tahvillerden elde edilen paralarla yeni fabrikalar kurarak fabrika atıklarını, su kullanımını ve küresel sera gazı emisyonlarını azaltmaktı (Financial Times, 2014). 2013 aynı zamanda Massachusetts tarafından ilk yeşil belediye tahvilinin ihraç edildiği yıl oldu. Yeşil tahvil gelirleri, temiz su, devlet binalarında enerji verimliliği, arazi

iyileştirme ve habitat restorasyonu gibi projeleri finanse etmek için kullanıldı. (Green City Bonds Coalition, 2015). Önümüzdeki yıllarda yeşil tahviller hükümetleri de cezbetti. Polonya, yeşil devlet tahvili ihraç eden ilk ülke oldu. 2016 yılında Polonya hükümeti demiryolu altyapısı, sürdürülebilir tarım, su ve toprağın korunması, ormanların ve vahşi yaşamın korunması gibi projeleri finanse etmek için yeşil tahvillerden 50 milyon Euro topladı (Ministry of Finance Republic of Poland, 2019).

Öte yandan, piyasalarda herkes tarafından kabul göre bir yeşil tahvil tanımı ya da bir tahvili neyin yeşil yapacağına karar verecek bir otorite henüz yok. Hükümetler, kurumsal şirketler, Sivil Toplum Kuruluşları, politikacılar, bankalar ve yatırımcıların kendilerine özgü tanımları vardır. Her tanım farklı kapsamlar, kısıtlamalar ve şeffaflık seviyeleri içeriyor.

Hal böyle olunca da piyasada yeşil tahvillerin standardizasyonu ihtiyacı ortaya çıkıyor. 2014 yılında, Uluslararası Sermaye Piyasası Birliği (ICMA), Yeşil Tahvil İlkeleri (GBP) adlı bir gönüllü kılavuz yayınladı. GBP, sermaye arayanlar için yeşil tahvil ihraç etmenin temel adımlarına ilişkin bir çerçeve sağlıyor. Aynı zamanda yatırımcıların yatırımlarının çevresel performansını değerlendirmelerine yardımcı oluyor (ICMA, 2018). GBP yeşil tahvil ihracında dört temel unsurda tanımlıyor.

İlk madde gelirlerin kullanımı. Bu madde yeşil tahvillerle finanse edilen tüm projelerin çevresel fayda sağlaması gerektiğini belirtir. Yeşil projelerin tanımları yatırımcılara net bir şekilde anlatılmalıdır. Firmalar, gelirlerin yeni projeleri finanse etmek için mi yoksa mevcut projeleri yeniden finanse etmek için mi kullanılacağı hakkında bilgi vermelidir. Uygun yeşil projeler de GBP tarafından şu şekilde listelenmiştir: yenilenebilir enerji, enerji verimliliği, kirliliğin önlenmesi ve kontrolü, doğal kaynakların ve arazi kullanımının sürdürülebilir yönetimi, biyolojik çeşitliliğin korunması, temiz ulaşım, iklim değişikliğine uyum, yeşil binalar ve döngüsel ekonomi. Ancak GBP, sektöre ve coğrafyaya bağlı olarak listenin uzayabileceğini de vurguluyor. İkinci madde ise proje değerlendirme ve seçim süreci ile ilgili. Bu madde yatırımcılarla şeffaf iletişimin önemini anlatmaktadır. Tahvil ihraç eden kuruluşların, projelerin çevresel hedefleri konusunda yatırımcıları bilgilendirmeleri tavsiye edilir.

Üçüncü madde ise gelirlerin yönetimi konusundadır. GBP, yeşil tahvillerden elde edilen net gelirlerinin yatırımcı tarafından izlenmesinde şeffaflığı teşvik eder.

Dördüncü ve son madde ise raporlama. Bu ilke, gelirlerin kullanımı, yeşil tahvillerle finanse edilen proje tanımları, gelirlerin nasıl yönetildiği ve projelerin çevresel etkileri hakkında güncel bilgilerin sağlanmasının önemini ele almaktadır. GBP, yıllık raporların yayınlanmasını teşvik eder.

GBP ayrıca ihraççıların yeşil tahvillerin GBP'nin dört bileşeni ile uyumluluğunu değerlendirmek için değerlendirici kurumlara başvurulmasını önermektedir. Bağımsız dış incelemeler, yeşil tahvilleri değerlendirmek için farklı kapsamlara sahiptir. ICMA'ya göre, yeşil pazarda yaygın olarak kullanılan dört harici inceleme vardır. Bunlar İkinci Taraf Görüşü, Doğrulama, Yeşil Tahvil Puanlaması/Derecelendirmesi ve Sertifikasyondur. GBP tarafından önerildiği gibi, dış gözden geçirenler yeşil tahvillerin GBP bileşenlerine uyumunu sağlayarak yeşil tahviller hakkında bağımsız görüş sağlayabilir. Bu kurumlara örnek olarak CICERO, Sustainalytics, Moody's, Barclays, Bank of America Merrill Lynch ve S&P verilebilir. Ancak, şu anda yalnızca İklim Tahvil Girişimi (CBI) yeşil tahvillere sertifika vermektedir.

Yeşil tahvil piyasasının başlangıcından bu yana, yeşil tahvillerin daha düşük sermaye maliyeti sunup sunmadığı veya yatırımcıların yeşil tahviller için daha yüksek fiyatlar ödemeye istekli olup olmadığı akademisyenler arasında tartışmalı bir konu olmuştur. Araştırmacılar yeşil tahvil piyasasının büyüyen boyutundan etkilenmiş ve yeşil tahvillerin fiyat dinamiklerini incelemiştir. Aynı ihraççılardan gelen yeşil tahviller aynı temerrüt riskini taşır. O halde araştırmacılar neden yeşil primle ilgileniyor? İhraççılar çevre dostu projelerini finanse etmek istiyorlarsa, tamamen normal konvansiyonel tahviller çıkarabilir. Neden geleneksel tahviller yerine bu nispeten yeni finansal araçları ihraç etmeyi seçsinler? Yeşil tahvillerin hangi özellikleri, geleneksel tahvillerle karşılaştırıldığında (varsa) bu fiyat farkına neden oluyor? Bu sorulara ve daha fazlasına cevap arayan önceki çalışmaların sonuçları ve yöntemleri şimdiye kadar farklı olmuştur. Akademisyenler, değişen gözlem periyotlarında farklı veri örneklerini kullanarak birincil piyasalarda veya ikincil piyasalarda yeşil primi incelediler. Çalışmaların çoğu, tahvil eşleştirme metodolojisi uygulayarak yeşil tahvil getirilerini

analiz etmiştir. Ancak yeşil tahvil priminin var olup olmadığı konusunda akademide bir fikir birliği yoktur. Kesin olan bir şey varsa o da sonuçların heterojenliğidir.

Araştırmacılardan bazıları (Preclaw ve Bakshi, 2015; Ehlers ve Packer, 2017; Zerbib, 2019; Kapraun ve Scheins, 2019; Gianfrate ve Peri, 2019; Agligardi ve Agligardi, 2019; Baker et al., 2018; Partridge and Medda, 2019) yeşil tahvillerin aynı şirketlerin normal tahvillerinden daha yüksek fiyatlarla piyasada işlem gördüğünü ve şirketler için düşük sermaye maliyeti sunduğunu tespit ettiler. Öte yandan, Hanhenberg ve Schiereck (2018), Karph ve Mendel (2018) yeşil tahvillerin daha düşük fiyatlarla işlem gördüğünü ve daha yüksek sermaye maliyeti sunduğunu ortaya çıkaran çalışmalar yaptılar. Larcker ve Watts (2020) ise yeşil ve normal tahviller arasında yatırımcı açısından bir farklılık yaratmadığını ve aynı fiyatlardan işlem gördüklerini tespit etmişlerdir.

Diğer taraftan bazı araştırmacılar ise yeşil tahvil getirileri üzerinde ikincil derecelendirme kurumlarının etkilerini araştırmışlardır. Bachelet et al. (2019), Hyun, Park ve Tian (2021), Simeth (2021), Fatica, Panzica ve Rancan (2021) bir derecelendirme kurumu tarafından değerlendirilen yeşil tahvillerin yatırımcılar tarafından daha çok rağbet gördüğünü ve bu taleplerin de yüksek fiyatlarla piyasaya yansıdığını kanıtladılar. Bağımsız dış incelemeler, yeşil tahvillere dair yatırımcılar arasındaki şirketlerin çevresel sorumluluklarla hareket ettiği algısını yaratıp ancak getirilerini bu amaçla kullanmadığı korkularının aşılması için önemli bir dayanak sağlıyor.

İşte bu çalışmada sertifikasyonun yeşil tahvil getirileri üzerindeki etkileri araştırılmıştır. Diğer çalışmalardan farklı olarak sadece CBI tarafından sertifika verilmiş olan yeşil tahviller çalışılmıştır çünkü CBI sertifikasyonu elde etmek pek çok aşamalı değerlendirmeden geçmeyi gerektiriyor. Örneğin her ikincil değerlendirmeye sahip yeşil tahvil sertifikasyona sahip değilken sertifikası olan her yeşil tahvil bir ikincil değerlendirme raporuna sahip olmak zorundadır.

Sertifikasyona ek olarak bu çalışmada şirketlerin çevre, sosyal, yönetimsel (ESG) puanlarının yeşil tahvil getirileri üzerinde nasıl bir etkisi olduğu araştırılmıştır. İlk

aşamada şirketlerin halka açık ESG puanlarının olmasının yeşil tahvil getirileri üzerindeki etkisi incelenmiş sonraki aşamada ise ESG puanlarının yüksek ve düşük olmasının yeşil tahvil getirileri üzerinde anlamlı bir etkisi var mı sorusu araştırıldı. Thomson Reuters (TR) veri tabanı tarafından yeşil tahvil olarak işaretlenen ve 1 Ocak 2007 ile 21 Kasım 2021 tarihleri arasında ihraç edilen tüm şirket tahvilleri bir excel dosyasında toplandı. İlk veri kümesi 1582 farklı şirket tarafından ihraç edilmiş 4196 yeşil tahvilden oluşuyordu. Daha sonra bu dosya Python'a aktarıldı ve başlıca numpy ve pandas kütüphaneleri kullanılarak veri temizleme işlemleri yapıldı. ISIN numaraları olmayan tahviller veri setinde kaldırılınca geriye 3927 kurumsal tahvil kaldı. CBI ilk defa 2015 yılında bir kurumsal tahvile sertifika verdiği için bu tarihten önce ihraç edilmiş tahviller veri setinden çıkartıldı. Daha dengeli bir karşılaştırma yapmak için kupan türü düz vanilya sabit kuponlu tahvillerle sınırlandırıldı. Bu aşamada geriye kalan tahvillerin birincil para birimleri kontrol edildi. Euro, Dolar, İsveç Kronası, Çin Yuanı, Japan Yeni, ve Güney Kore Wonu para birimlerinde ihraç edilen tahviller veri setinin % 83.94'ünü oluşturduğu için veri seti bu para birimlerinde ihraç edilen tahvillerle sınırlandırıldı ve geriye 2473 yeşil tahvil kaldı. Sonraki aşamada, geriye kalan bu yeşil tahvilleri piyasaya ihraç eden şirketlerin yeşil olmayan normal tahvillerinin bilgisi toplandı. 2015'ten sonra ihraç edilmiş, yukardaki para birimlerine sahip, düz kupon tahvillerle veri seti sınırlandırıldı. Önemli bir nokta olarak her aşamada her bir yeşil tahvil ihraççısının en azında bir tane yeşil olmayan normal tahvilinin veri setinde bulunması şart koşuldu. Bu tahvillere ait günlük getiri bilgisi de TR veri tabanından toplanıp, her bir tahvilin en azından 504 günlük verisi olması şartı getirildi. En son aşamada analizleri yapmak üzere veri setinde 162 farklı şirket tarafından ihraç edilmiş 253 yeşil tahvil ve 3375 yeşil olmayan tahvil kaldı.

Bu 253 yeşil tahvilin CBI tarafından verilmiş bir sertifikalarının olup olmadığı tek tek CBI web sitesi üzerinden indirilen sertifikalı tahvil listesi baz alınarak kontrol edildi. 22 tane yeşil tahvilin sertifikası olduğu tespit edildi. Bununla birlikte geriye kalan şirketlerden kaç tanesinin halka açık ESG puanlarının olduğu yine TR veri tabanı üzerinden kontrol edildi. 64 şirkete ait 105 yeşil tahvil ve 1042 normal tahvil için ESG bilgisinin olduğu tespit edildi. Günlük toplam getiriler ile ESG puanları birleştirildiğinde ise ESG puan bilgisi olmayan yıllara ait gözlemler örneklemden

çıkarıldı. ESG puanlarının günlük veriler üzerindeki etkisini ölçmek için 62 şirkete ait 102 yeşil tahvil ve 995 normal tahvil veri setinde kaldı.

Bu bağlamda incelemek üzere beş hipotez öne sürüldü:

Hipotez 1: İkincil piyasada kurumsal yeşil tahvillere olan talep, aynı ihraççıların kurumsal kahverengi tahvillerine olan talepten daha yüksek olacaktır. Artan talep, tahvillerin toplam günlük getirilerine yansıyacaktır. Diğer bir deyişle, yeşil tahviller ikincil piyasadaki kahverengi tahvillere kıyasla daha yüksek toplam günlük getiriye sahip olacaktır.

Hipotez 2: CBI sertifikası daha yüksek güvenilirlik sağladığından ve yeşil yıkama endişelerini hafiflettiğinden, CBI Sertifikalı kurumsal yeşil tahvillere olan talep, CBI sertifikası olmayan yeşil tahvillere ve aynı ihraççıların kahverengi tahvillerine göre daha yüksek olacaktır. Bu nedenle, CBI Sertifikalı kurumsal yeşil tahviller, CBI sertifikası olmayan yeşil tahvillerden ve aynı ihraççıların kahverengi tahvillerinden daha yüksek günlük getiri elde edecektir.

Hipotez 3: Halka açık ESG derecelendirmesine sahip şirketler tarafından ihraç edilen yeşil tahvillerin, ESG derecelendirmesi olmayan şirketler tarafından ihraç edilen yeşil tahvillerden daha yüksek günlük toplam getiriye sahip olması beklenmektedir. ESG notlarının varlığı şirketin kredibilitesini artıracağından yatırımcılar bu tahvilleri daha çok tercih edeceklerdir. Daha yüksek talep, daha yüksek günlük toplam getiri ile kanıtlanacaktır.

Analizin bağımlı değişkeni, kurumsal yeşil tahvillerin ve kurumsal kahverengi tahvillerin toplam günlük getirileridir. Devlet tahvili getirileri, kupon oranı, vade, çağrılabilirlik ve kıdem, Merton (1974) tarafından şirket tahvili fiyatlamasını etkileyen faktörler olarak sıralanmıştır. Bu noktadan hareketle piyasa genelinde açıklayıcı bir değişken olarak seçilen para birimlerine ait 10 yıllık devlet tahvillerinin günlük alış getirileri denkleme dahil edilmiştir. Tahvil özellikleri, tahvillerin çağrılabilirliği, vadesi ve kıdemleri kukla değişkenlerle kontrol edildi. Kupon oranları ve ABD doları cinsinden ihraç tutarının doğal logaritması, (Bao, Pan ve Wang, 2011) tahvil

özelliklerinin kurumsal tahvil getirileri üzerindeki etkisini kontrol etmek için tahvil kontrol değişkenleri olarak denkleme dahil edilmiştir. Ayrıca, firma özellikleri finansal ve kamu hizmeti ikili değişkenleri ile tarafından kontrol edildi. Hipotez 1, 2 ve 3 metin içine açıklanan Denklem 2 ile test edilmiştir.

Hipotez 3'te, halka açık ESG notlarına sahip şirketler tarafından ihraç edilen yeşil tahvillerin ikincil piyasada daha yüksek getiri elde edeceği iddia edilmektedir. Hipotez 4'te yatırımcıların yeşil tahvil alırken ihraççıların ESG puanlarındaki değişikliklere mi yoksa sadece ESG puanının varlığına mı dikkat ettikleri araştırılmıştır.

Hipotez 4: Şirketin ESG Puanı arttıkça yeşil tahvil getirilerinin artması beklenmektedir. Daha yüksek ESG puanı, şirketin çevre dostu olduğunu işaret edeceğinden, daha iyi ESG Puanları ikincil piyasada daha yüksek yeşil tahvil getirilerine yol açmalıdır.

İhraççıların ESG Puanlarını nasıl algıladıkları belirsizdir. Bu nedenle, ESG Puanlarını doğrudan analize dahil etmek yerine, belirli tanımlara dayalı olarak ESG Sınıfı değişkenleri oluşturuldu. İki sınıf özelliği tanımlandı. İlk olarak 85 puan ve üzeri ESG Puanları 1, aksi halde 0 olarak kabul edildi. İkinci sınıflandırma örneklemdeki yıllık ESG puan dağılımlarına göre yapıldı. İhraççının ESG Puanı ilgili yıl için ilk %10'da ise, ESG Sınıfı kukla değişkeni 1, aksi halde 0 olarak kabul edilirdi. Hipotez 4, metin içinde verilen Denklem 2 ile test edildi.

ESG Puanı, şirketlerin çevresel, sosyal ve yönetişim puanlarına göre hesaplanmaktadır. Çevreye ait puan türü yeşil tahvil kavramıyla daha çok ilgilidir. Bu sebeple, firmaların kümülatif ESG puanı yerine çevre puanı yeşil tahvil getirilerini daha fazla etkilemelidir. Bu düşünceden hareketle Hipotez 5 öne sürüldü. ESG Puanına benzer şekilde, çevresel puan için de bir sınıf kukla değişkeni tanımlandı ve iki sınıf değişkeni varsayımı belirlendi.

Hipotez 5: Şirketin çevresel puanı arttıkça yeşil tahvil getirilerinin artması beklenmektedir.

Denklem biri test etmek için kullanılan veri seti yeşil ve kahverengi tahvillere ait toplam 3,449,683 günlük veriden oluşan dengesiz panel veri modeli. Stata panel verileri analiz etmek için çok sayıda seçenek sunduğu için Python'da analize hazır hale getirilmiş data seti Stata'ya aktarıldı. Analizden önce aykırı değerlerin etkilerini ortadan kaldırmak için Stata'nın winsor fonksiyonu kullanıldı. 1. yüzdelik dilimden küçük ve 99. yüzdelik dilimden yüksek olan bağımlı değişken değerleri kırpıldı. Verilerin panel veri özelliklerini gösterip göstermediğini anlamak için öncelikle Breusch ve Pagan Lagrange Çarpan Testi yapıldı. Breusch ve Pagan Lagrange Çarpan testinin boş hipotezi, rastgele etkinin varyansının sıfır olmasıdır. Boş hipotez reddedilirse, bu, panel veri regresyon analizi modellerinin analiz için daha uygun olduğu anlamına gelir. Değilse, analiz için havuzlanmış en küçük kareler regresyonu seçilmelidir. Tablo 10'da gösterilen test sonuçlarına göre, Breusch ve Pagan Lagrange Çarpan Testi'nin sıfır hipotezi reddedildi. Daha sonra sabit etkili panel veri modeli ile rastgele etkili panel veri modeli arasında seçim yapmak için Hausman testi yapıldı. Hausman testinin sıfır hipotezi, modelde rastgele etkilerin bulunduğunu belirtir. Tablo 1'de verilen Hausman testi sonucu anlamlı olmadığı için boş hipotez reddedilemedi ve Denklem 1'in analizi için rastgele etkiler panel modeli seçildi. Daha sonra değişen varyans ve seri otokorelasyonun tespiti için Modified Wald testi ve Wooldridge testi yapıldı. Modelin hem deşien varyans hem de otokorelasyon sorunlarını taşıdığı tespit edildi. Analiz sonuçları Table 13'te verilmiştir.

Bu analizde ilgilenilen değişkenler Green, CBI, ESG, Green x ESG bağımsız değişkenleridir. Beklentiler doğrultusunda, kurumsal yeşil tahviller, kahverengi muadillerine göre daha yüksek getiri elde ediyor. Bu sonuç Hipotez 1'i desteklemektedir. Kurumsal yeşil tahviller, ikincil piyasadaki kahverengi muadillerine göre 20 baz puan daha yüksek günlük getiri ile işlem görmektedir. Bu durum, yeşil tahvillere yönelik artan talep ile açıklanabilir. Yatırımcıların yeşil tahvilleri tercih etmesinin çeşitli nedenleri olabilir.

İlk olarak, düşük karbon ekonomisine geçişin bir parçası olmak isteyen yatırımcılar, portföylerinde yeşil tahvil bulundurarak üzerlerine düşeni yapabilirler. Yatırımcıların zihniyetindeki bu değişim, daha yüksek talepler ve daha yüksek yeşil tahvil getirileri ile ikincil piyasaya doğrudan yansıyor. Başka bir deyişle, daha sürdürülebilir bir

gezegene katkıda bulunmak amacıyla çevresel tercihler, yeşil tahvillerdeki fiyatları yönlendiriyor. Ayrıca, yatırımcılar iklim değişikliğinin bir sonucu olarak giderek artan çevresel risklerden kaynaklanan finansal riskleri azaltmak istemiş ve bu sebeple portföylerinde yeşil tahvil tutmayı tercih etmiş olabilirler. Yeşil tahvillerin gelirleri, bu tür olası sorunlarla başa çıkmayı amaçlayan çevresel projeleri finanse etmek için kullanılıyor. Yenilenebilir enerjiden, biyolojik çeşitliliğin korunmasına, geri dönüşümden karbonsuz ulaşıma kadar geniş bir yelpazede sunulan yeşil tahviller yatırımcılara, değerlerini en iyi yansıtan tahvili seçme özgürlüğü tanıyor. Son olarak, yatırımcılar geleneksel tahviller yerine yeşil tahvilleri tutarak paralarının nasıl kullanıldığını takip edebilirler. Bunun nedeni, yeşil tahvil ihraççılarının, yeşil tahvil ihraçlarından elde edilen parayı nasıl ve hangi amaçlarla harcadıklarını raporlarla yatırımcılara sunmalarının gerekliliğidir. Bu nedenle, daha fazla yatırımcıyı cezbetmek ve yeşil tahvil piyasasının geleceği için raporlama ilkelerinin geliştirilmesi ve standardize edilmesi büyük önem taşıyor. Bekleneni aksine sertifikaların yeşil tahvil getirilerine bir etkisi tespit edilemedi. Diğer taraftan örneklemdeki sertifikalı tahvil sayısının az olduğu düşünülürse bu sonucu genellemek doğru olmayacaktır. Son olarak şirketlerin halka açık bir ESG puanlarının olmasının yeşil ve kahverengi tahviller üzerinde pozitif ve anlamlı bir etkisi varken yeşil tahviller üzerinde ayrıca anlamlı bir etkisi olmadığı tespit edildi.

Yukarda belirlenen panel veri testlerinden sonra ikinci denklemin analizinde standart hataları düzeltilmiş doğrusal panel veri modeli kullanıldı. Analizin sonuçları Tablo 16'da veriliyor. Analizin ilgili değişkenleri Green, ESG Class, ve Green x ESG Class değişkenleridir. ESG sınıf değişkenin katsayısı her iki senaryoda da anlamlı olmazken ESG sınıf değişkeni ile yeşil tahvil değişkeninin çarpımı olan Green x ESG Class değişkenin katsayısı anlamlı ve negatif bulundu. Bu durum, ESG puanı yüksek olan şirketlerin ihraç ettiği yeşil tahvillere olan talebin, daha düşük ESG puanına sahip şirketlerin ihraç ettiği yeşil tahvillere olan talepten daha düşük olduğu anlamına gelebilir. Yatırımcılar, yüksek ESG puanına sahip şirketlerin kahverengi tahvillerini satın almayı tercih edebilirler. Yani bir diğer deyişle şirketlerin ESG puanları yüksek olduğunda, yatırımcının çevre dostu yatırımlara olan talebi yeşil tahviller ve kahverengi tahviller arasında bölünüyor olabilir. Bu bağlamda, yatırımcıların tahvil gelirlerinden ziyade şirketlerin ESG itibarını daha fazla önemsiyor olduğu sonucu

ortaya çıkıyor. Yeşil tahvil piyasası denetim standartları iyileştirdikçe yatırımcının yeşil tahvillere bakış açısı güçlendirecektir. ESG Class x Green değişkeni ile Green değişkenin katsayılarının toplanmasının anlamlı olup olmadığını test etmek için T test yapıldı. Test sonucu bu toplamın istatistiksel olarak anlamlı olmayacağını verdi. Yani kesin olarak olarak yüksek ESG puanları yeşil tahvillerin getirilerini düşürüyor demek doğru olmayacaktır.

Diğer taraftan üçüncü denklemin analizinde de çevresel skorlar ile yeşil tahviller arasında yine anlamlı bir ilişki gözlenmedi. Analizin ilgili değişkenleri Green, EPS Class, ve Green x EPS Class değişkenleridir. ESG sınıf değişkeni hem yeşil hem kahverengi örneklemdeki tüm tahvillerin getirilerinin artırırken bu durum çevresel faktörün etkisinin ölçüldüğü EPS sınıf değişkeninde tespit edilemedi. Analiz sonuçlarına göre yatırımcılar çevre puanlarından ziyade bileşik ESG puanlarını daha çok dikkate alıyorlar. Ancak akılda tutulması gereken önemli bir nokta da şu ki sınıf değişkenleri yazarların sınıf tanımlarına göre oluşturuldu. Farklı denemeler farklı sonuçlar doğurabilir.

Bu çalışmada gözlem periyodu 2015 yılından 2021 yılını kapsamaktadır. Covid 19 pandemisinin başlangıcı bu sürece dahil olduğu için pandeminin analizler üzerindeki etkisi de araştırıldı. Dünya Sağlık Örgütü 11 Mart 2020'de Covid-19 salgınını pandemi olarak nitelendirdi. Bu tarih baz alınarak veri seti pandemiden önce ve sonra olmak üzere ikiye bölündü. İkinci ve üçüncü denklemin analizleri tekrarlandı.

Tablo 18, pandemi öncesi ve sonrası için ikinci denklemin panel regresyon analizinin sonuçlarını göstermektedir. Yeşil tahvillerin getirileri, pandemi sonrası her iki ESG Sınıf senaryosunda da arttı. Bu sonuç, Covid 19 pandemisinin yeşil tahvil getirileri üzerindeki etkilerine ilişkin son çalışmaları desteklemektedir (Yi ve ark. 2021; Guo ve Zhou, 2021; Hacıömeroğlu ve ark. 2021). Pandemiden sonra, yatırımcıların çevre bilinci ve iklim krizi algısı değişti. Bunun doğal sonucu olarak da yeşil tahvillere olan talep arttı. Diğer taraftan ESG Class ve Green çarpım değişkenin kat sayısı pandemi öncesi ve sonrasında her iki senaryoda da negatif çıktı ancak tanımlanan sınıf değişkenine bağlı olarak istatiksel olarak anlamlı olup olmadığı değişiklik gösterdi. Bu sepeble yüksek ESG puanlarının yeşil tahviller üzerindeki etkisine yönelik genel

bir çıkarımda bulunmak doğru olmayacaktır. Tablo 23'te verilen sonuçlara göre EPS sınıf değişkeni pandemiden sonra örneklemde bulunan tüm tahvillerin getirileri üzerinde pozitif ve anlamlı bir etkiye sahip ancak EPS Sınıf değişkeninin yeşil tahviller üzerinde ayrıca anlamlı bir ilişkisi olduğu gözlemlenmedi.

F. THESIS PERMISSION FORM / TEZ İZİN FORMU

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TEZİN ADI / TITLE OF THE THESIS (**İngilizce** / English): The Effect of Certification on Green Bond Returns

TEZİN TÜRÜ / DEGREE**:** **Yüksek Lisans** / Master ☒ **Doktora** / PhD ☐

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