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INVESTING IN A GREENER TOMORROW: UNVEILING THE POTENTIAL OF GREEN AND TRANSITION BONDS IN ENVIRONMENTAL GOAL REALIZATION

Master Thesis

By
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MSc in Business with Major Sustainable Finance

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ABSTRACT

In this study I look into the relationship between green and transition bonds and their impact on achieving the climate change mitigation targets of their issuers. I determine whether purchasing green bonds is a better way to invest in the environmentally friendly future or whether transition can be a game changer in impact investing in fixed-income market. By using comparison analysis to determine the effect of bonds by comparing historical emissions and Scope 1 and 2 of issuers with the level after issuance of green or transition bond. I found that green bonds have an insignificant impact in reducing CO_2 emissions, indicating limited effectiveness in achieving environmental goal. I also discovered an unexpected positive coefficient for transition bonds. Based on my findings, I conclude that alternative strategies may be necessary to address CO_2 emissions and promote sustainable development.

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1 INTRODUCTION AND MOTIVATION

The urgent need to combat climate change and promote sustainability has brought the whole world together. One of the most discussed global initiatives is the Paris Agreement. The signatories of the agreement have committed to increase their dedication to building a sustainable society and advancing the implementation of the Sustainable Development Goals (SDGs) in conjunction with private sector entities. Collaboration between governments and businesses has emerged as a crucial factor in facilitating the shift towards a more environmentally sustainable future.

Financial markets have recognized climate change as a systemic risk to long-term investments in fixed income portfolios. The financial world is overlooking certain industrial sectors, that are often regarded as majors contributors to global warming, including the fossil fuel industry and its associated sectors. As a result, practitioners now view the shift to “green finance” as being more crucial (Duteil, 2019). Over the past decade, there has been a notable surge in the private sector’s interest in green investment, with financial institutions redirecting client assets towards climate mitigation projects. Along with their variations, such as the SDGs, social development, pandemic emergencies, gender equality, forestation, green bonds have emerged as to go-to strategy for promoting a more effective and environmentally friendly use of natural resources and its financing (Duteil, 2019).

Green bonds have gained prominence in the fixed income market, and the capital markets have positively responded, ensuring that plans for reducing global warming can be financed with investment capital. According to a study conducted by the G20 Green Finance Study group (2016), the classification of green bonds accounts for less than 1 % of the global bond market, while assets held by international institutional investors that fall under the green category represent a similar proportion of 1%. There is a clear market opportunity for finance through transition bonds, which can be issued by business that are currently not environmentally friendly but demonstrate intentions to adopt sustainable practices in the future.

The industries that stand to benefit most from the utilization of transition bonds are those that primarily deal with energy, commodities, and raw materials. This is especially apparent in developing markets, where there is a significant market potential for the issuance of transition bonds due to their high reliance on sectors that generate substantial of greenhouse gas emissions. To support the transition and to limit the global warming to 1.5 degrees, it is estimated that around 359 trillion USD in funding will be required (Cermeno, 2022). Given the profound influence of new green technologies in reducing carbon emissions, a majority of investment allocation should be directed towards the energy and transportation sectors.

Investors have demonstrated a robust and growing interest in financing bond issuance through financial markets that not only contribute to mitigating of climate change but also provide attractive returns (Kaminker et al., 2017). However, supply of funding falls short of demand from business seeking to implement energy-optimization system in their operations and products. Consequently, capital markets must therefore devote significantly more resources to address climate risks. Transition bonds emerge as a new category of fixed-income instruments designed to support company's transition towards project with a reduced environmental impact or aimed at lowering their carbon emissions. Essentially, the issuer commits to adopting more environmentally friendly business practices by directing the bond proceeds solely towards ongoing projects or initiatives that qualify as transition projects (Riordan, 2019). This approach gives business access to capital for their sustainability efforts and enables investors to support and participate in the transition to a greener economy.

This master's thesis explores the investment opportunities within fixed-income market and their impact on mitigating climate change. Existing studies indicate that both green bonds and assets exclusively represent a mere 1% of the overall market, underscoring their inadequacy in meeting the financing requirements for environmental goals. Despite this, green bonds continue to be favors over transition bonds. The research question driving this study is therefore as follows:

"In the pursuit of environmental goal realization, can transition bonds supplant green bonds?"

The primary objective of this research is to determine which of these financial instruments, when utilized by companies, government, or other relevant governmental bodies, exerts a more significant influence on reducing Scope 1 and 2 emissions. Through regression analysis and hypothesis testing, the results indicate that while green bonds show a slight decrease in CO_2 emissions and transition bonds exhibit a slight increase, none of these results reach statistical significance. Therefore, the findings suggest the need for further investigation and alternative strategies to effectively address CO_2 emissions and foster sustainable development.

2 LITERATURE REVIEW AND THEORY

This chapter outlines and discusses current literature, focusing on the key areas of study. Firstly, the chapter introduces the concept of green and transition bonds and emphasize the need for investments to combat climate change. The literature review delves into advantages offered by existing green investment instruments in the realm of fixed income, such as improved transparency for the financial sector, and compare their financial performance to that of traditional bonds. Through a thorough analysis of the current landscape, the literature acknowledges the necessity for new financial instruments to facilitate climate transition financing.

2.1 Bonds

A bond is a fixed-income security utilized for borrow money or raising funds (Riordan, 2021). Investors have the opportunity to purchase bonds from companies, governments, or other governmental bodies in exchange for receiving periodic interest payments, known as coupons, and return of the initial investment, known as principal, at the predetermined future date. Bonds are commonly issued to secure funds for ongoing investments or specific projects.

A green bond is a specific type of bond that aims to generate funds to support environmental or climate change mitigation projects. The issuers of green bonds make a commitment to provide comprehensive updates to investors about the infrastructure and projects that will be finances using the bond proceeds. The World Bank issued its first green bond in November 2008 in direct response to a request made by consortium of Swedish pension funds seeking investment opportunities related to climate change (Riordan, 2021). This ground-breaking issuance, recognized as the world’s first green bond, served as a blueprint for the current green bond market. It provided investors with means to support climate solutions through their investments while still maintaining financial returns. In today's market, any company, government, or governmental body capable of issuing regular bonds also has the possibility to issue green bond.

When the issuance of debt fails to meet the requirements for green financing, a transition bond or transition financing becomes relevant (Riordan, 2019). Transition bonds are instruments in financing the transition of companies or government agencies towards reduced environmental impact and/or lower carbon emissions. They can be used to fund various climate transition-related activities, such as converting fuel-powered ships to natural gas, or transitioning fuel-powered oil platforms to electricity.

One notable example that justifies the viability of such financing options is the issuance of a transition bond by Brazilian beef producer Marfrig in 2019. Marfrig initially attempted to issue a green bond to address sustainability concerns in its supply chain, aiming to use the funds exclusively for purchases from suppliers committed to avoid deforestation. However, Marfrig operated in a sector that did not align with traditional "green" standards, posing a challenge. This predicament was ultimately resolved by repositioning the bonds as a "sustainable transition bond" (Riordan, 2019).

2.2 Green bonds funding the transition?

The utilization of green bonds stands out as a prominent advancement in sustainable finance. Nevertheless, the conceptual and empirical understanding of how green bonds contribute to businesses achieving carbon neutrality remains limited.

In their study, Tuhkanen and Vulturius (2020) conducted an examination of the twenty largest European green bonds issued in 2018. Their objective was to develop and evaluate a conceptual framework that establishes a connection between green bonds and climate targets. The researchers uncovered a recurring discrepancy between the climate targets set by issuers and the framework established for their green bonds. Furthermore, they identified several issues related to post-issuance reporting by these issuers. The study's findings indicate that green bonds issuers face limited pressure to utilize the proceeds in alignment with ambitious science-based goals.

This highlights the significance of policy interventions to mitigate the risks of greenwashing and ensure that the green bond market operates within the boundaries of planetary sustainability.

Enabling investor attraction and addressing financial market barriers play crucial role in facilitating an effective transition to a low-carbon economy. Lichtenberger, Braga and Semmler (2022) conducted a study to examine the performance disparity between green and non-green bonds. Their research employed a dynamic portfolio model that incorporates positive and negative externality effects, along with econometric analysis of time-series indices for corporate energy and green bond aggregates. The asset pricing model utilized in the study demonstrates that green bonds generate positive externalities that, over time, contribute to favorable social returns and stimulate economy. The econometric analysis reveals that green bonds generally exhibit lower volatility and better Sharpe ratio (though evidence for green premia is inconclusive). Consequently, investing in green bonds can offer portfolio protection and shield investors from oil price fluctuations, business cycle variations, while stabilizing portfolio returns and volatility. To accelerate the transition to a low-carbon economy, policymakers are urged to leverage the financial advantages offered by green instruments and enhance flow of funds towards sustainable economic activities. This strategic approach is crucial for harnessing the potential of the financial sector in driving the low-carbon transition.

2.3 Financing brown to green

Ever since the introduction of green bonds, capital markets have achieved remarkable advancements in mobilizing investment capital to back initiatives targeting the mitigation on global warming. Nonetheless, it is imperative to recognize that further action is necessary as the current efforts remain insufficient.

Sustainability-linked bonds (SLBs) offer a promising approach by integrating issuers' sustainability performance against predefined targets with general purpose debt financing. Vulturius, Maltais and Forsbacka (2022) emphasize in their study that SLBs have the undeniable potential to incentivize investments in zero-emission activities, assist issuers in aligning their emission trajectory with the Paris Agreement, and provide funding for commercial activities that support the transition to a sustainable future. However, several factors, including the establishment of a shared understanding of acceptable economic activities and the identification of significant performance indicators, must be carefully considered before the SLB market can fully unlock its potential to accelerate the transition to a low-carbon economy. This transition is of utmost importance in order to restrict global warming to levels below 2 degrees Celsius, and ideally, below 1.5 degrees Celsius.

2.4 Transitioning with bonds

The current research suggests that green bonds may not be fully effective in financing our environmental goals as intended. However, these studies primarily focus on recommendations for governments and regulators to strengthen existing directives, mitigate greenwashing risks, and encourage companies to issue green bonds that align with their environmental objectives. Notably, there is a noticeable lack of research on transition bonds and their impact on facilitating the green transition and achieving our environmental goals.

This thesis aims to address this research gap by making valuable contributions to the existing literature in key area:

- Increasing the research on transition bonds in general.
- Providing insights into the potential effects that transition bonds can have on transitioning to a carbon-neutral economy.

By exploring these aspects, this thesis will enhance our understanding of transition bonds and their role in driving the necessary shift towards a sustainable future.

3 METHODOLOGY

3.1 Testable hypotheses

According to the findings of several studies in the literature review, it has been observed that green bonds have limited effectiveness in facilitating the achievement of companies' environmental targets. There are various reasons contributing to this outcome. Consequently, it is reasonable to anticipate that green bonds may have a minimal or insignificant impact on CO_2 emissions of the company or government under consideration:

H1. The issuance of green bond has insignificant impact on reducing the CO_2 emissions.

H1a. The issuance of green bond has significant impact of reducing the CO_2 emissions.

Currently, there is a scarcity of studies that examine transition bonds and their impact on environmental objectives. Considering their purpose and their role in facilitating the transition from a predominantly fossil fuel-based economy to a low or zero-carbon economy, anticipated outcome suggests that transition bonds would have a beneficial impact on the CO_2 emissions of the utilities in question:

H2. The issuance of transition bond has positive impact on reducing the CO_2 emissions.

H2a. The issuance of transition bond has no positive impact on reducing the CO_2 emissions.

3.2 Research approach

The primary methodology employed in this thesis is a comparative study analysis approach. This approach involves the comparison and analysis of two or more thing or concepts, highlighting their similarities and differences. By observing different groups that have undergone various treatments, whether by circumstance or choice, it becomes feasible to identify and quantify the relationship between multiple variables (Bukhari, 2011). The purpose of this study is to explore the association between the issuance of green and transition bonds and the change in CO_2 emission of the issuer. The main goal is to assess the potential significance of green and transition bonds in mitigating CO_2 emissions, thereby contributing to the realization of environmental objectives. In order to achieve this objective, regression analysis is employed as the chosen analytical methodology.

Regression analysis is a statistical method used to examine the association between a dependent variable, in this case the change in CO_2 emission, and one or more independent variable, in this case the issuance of green and transition bonds, while accounting for potential confounding factors. Through this method, it is possible to determine the statistical significance and direction of the association between these variables. In order to enhance, the robustness and validity of the results, the regression model will incorporate relevant control variables. These variables capture industry-specific characteristics (energy intensity), regulatory compliance and other factors that have been identified or hypothesized to impact CO_2 emissions. By including these variables in the model, it can be effectively addressed their potential effects and isolate the specific impact of green and transition bond issuance on CO_2 emissions.

The estimation of the regression model will provide valuable insights into both the direction and magnitude of the relationship between issuance of green and transition bonds and the change in CO_2 emissions. These findings will enhance the understanding of the effectiveness of green and transition bonds in advancing environmental objectives. Through the utilization of this rigorous analytical approach, the objective is to present robust empirical evidence and make a meaningful contribution to the existing knowledge in this field.

3.3 Regression model

This study presents two separate regression models to investigate the individual impacts of green bonds and transition bonds on CO_2 emissions. By examining green and transition bonds in separate models, this study aims to evaluate their individual effects on achieving environmental goals. This analysis offers a comprehensive understanding of the effectiveness and relative contribution of green bonds and transition bonds in mitigating CO_2 emission and advancing sustainable finance practices.

3.3.1 Green bonds

$$\Delta\, CO_2\ emissions = \beta_0 + \beta_1 * green\ bond + \beta_2 * energy\ intensity$$
$$+ \beta_3 * regulatory\ compliance + \beta_4 * pandemic\ impact + \varepsilon$$

In this regression model:

- $\Delta\, CO_2\ emissions$ is the dependent variable that represents the change in CO_2 emissions.

- $green\ bond$ is the independent variables representing the type of bond issued. With $green\ bond$ taking value of 1 if it is a green bond and 0 otherwise.
- $energy\ intensity$, $regulatory\ compliance$ and $pandemic\ impact$ represent additional control variables that account for potential influences on CO_2 emissions
- β_0, β_1, β_2 β_3 and β_4 are coefficients that measure the impact of each variable on CO_2 emissions.
- ε is the error term, capturing the unexplained variation in CO_2 emissions (dependent variable).

3.3.2 Transition bonds

$$\Delta\ CO_2\ emissions = \beta_0 + \beta_1 * transition\ bond + \beta_2 * energy\ intensity + \beta_3 * regulatory\ compliance + \beta_4 * pandemic\ impact + \varepsilon$$

In this regression model:

- $\Delta\ CO_2\ emissions$ is the dependent variable that represents the change in CO_2 emissions.
- $transition\ bond$ is the independent variables representing the type of bond issued. With $transition\ bond$ taking value of 1 if it is a green bond and 0 otherwise.
- $energy\ intensity$, $regulatory\ compliance$ and $pandemic\ impact$ represent additional control variables that account for potential influences on CO_2 emissions
- β_0, β_1, β_2 β_3 and β_4 are coefficients that measure the impact of each variable on CO_2 emissions.
- ε is the error term, capturing the unexplained variation in CO_2 emissions (dependent variable).

3.4 Type of data

To effectively address the research question, obtaining specific types of data is necessary to build a regression model incorporating relevant control variables. The dependent variable in this model is the change in CO_2 emissions over a given period. To analyze this, reliable and accurate data on CO_2 emissions for the companies under investigation would be required.

The independent variables of interest are the green and transition bond. To evaluate whether transition bonds can replace green bonds in the pursuit of environmental goals, data categorizing each bond issuance as either a green or transition bond is needed. The data should indicate whether each bond is specifically classified as a green bond (assigned a value of 1) or not (assigned a value of 0). Similarly, the transition bond variable requires data indication whether each bond is a transition bond (assigned value of 1) or not (assigned a value of 0).

In addition to the bond types, several control variables are necessary to account for other factors that might influence CO_2 emissions. The initial control variable, energy intensity, captures the energy consumption and efficiency of the industries or sectors studied. To assess the impact of energy intensity on CO_2 emissions, data quantifying energy intensity such as energy consumption levels or intensity indexes, is necessary. The second control variable, regulatory compliance, captures the influence of regulatory measures on CO_2 emissions. Assessing its impact necessitates data on the level of compliance with environmental regulations or standards within relevant industries or sectors. The third control variables, pandemic impact, represents the influence of the COVID-19 pandemic on CO_2 emissions. By including this variable in the regression model, the study acknowledges the potential influence of the pandemic on CO_2 emissions and aims to control for this factor when assessing the individual impacts of green and transition bonds.

By incorporating these variables into the regression model, we can assess the relationship between different bond types and CO_2 emissions while considering the influence of other possible aspects. Ultimately, this will enable us to evaluate whether transition bonds have the potential to replace green bonds in achieving environmental goal realization.

3.5 Interpretation of results

Interpreting the results of a regression analysis involves considering the sign and significance of the coefficients. The coefficients represent the estimated change in the dependent variable (CO_2 emission) associated with one-unit change in the independent variable (green bond/transition bond) while holding other variables constant. A positive coefficient suggests that the issuance of green/transition bond is associated with an increase in CO_2 emissions and negative coefficient suggest that the issuance of green/transition bond is associated with a decrease in CO_2 emissions. This also applies to coefficient of control variables. The significance of the coefficients is determined through statistical tests, and a significant coefficient indicates a robust relationship. To determine the significance of the coefficients in the regression model, it is possible to assess their p-values.

If the coefficient for transition bonds is statistically significant and has a positive sign, it suggests that transition bonds are associated with an increase in CO_2 emissions compared to green bonds This would indicate that transition bonds may not be as effective as green bonds in pursuing environmental goal realization.

On the other hand, if the coefficient for transition bonds is statistically significant and has a negative sign, it implies that transition bonds are associated with a decrease in CO_2 emission compared to green bonds. This would suggest that transition bonds have the potential to replace green bonds in contributing on environmental goal realization.

4 DATA

This study utilizes predominantly Bloomberg data, given its comprehensive coverage of tradable bonds. By focusing on widely accessible instruments that can be utilized by various stakeholder to achieve environmental goals, this research aims to provide insights into the effectiveness of these bonds in promoting sustainable finance practices. The use of Bloomberg data ensures robust and reliable information for analyzing the impact of these instruments on environmental goal realization.

The dependent variable in this study is derived from data obtained from Bloomberg that provides comprehensive environmental, social and governance (ESG) data, including information on carbon emissions. The variable comprises Scope 1 and Scope 2 emissions, which are the primary components of the measurement. The data is predominantly sourced from the companies themselves, but Bloomberg also includes some estimations to complete the dataset. To capture the impact of transition and green bonds, two values are considered. The first value represents the combined Scope 1 and Scope 2 emissions reported or estimated in the year preceding the issuance of the bonds. The second value represents the combined emission reported or estimated in the year of bond issuance. By including emissions value reported or estimated in the same year as the issuance of the bond, the analysis enables a direct assessment of the immediate impact of the bonds on CO_2 emissions. To quantify the impact, the study calculates the change in these variables:

$$\%\Delta\, CO_2\ emissions = \frac{CO_2\ emissions\ (year\ of\ issuance) -\ CO_2\ emissions\ (year\ before\ issuance)}{CO_2\ emissions\ (year\ before\ issuance)} * 100$$

The percentage change in emissions can be obtained by subtracting the emissions value of the year before issuance from the emissions value of the year of issuance, dividing it by the emissions value of the year before issuance, and then multiplying by 100. This change provides a measure of the influence of the bonds on emission reduction or increase during specific timeframe.

Notably, Scope 3 emissions, which are associated with the value chain of companies, are not included in the analysis. This decision is based on the understanding that the direct influence of the bond is less likely to extend to Scope 3 emissions in most cases.

The independent variables are dummy variables constructed to represent the presence or absence of transition and green bonds. The inclusion of dummy variables for transition and green bonds enables the analysis of the influence of these specific types of bonds on CO_2 emission. These binary variables indicate whether a company has issued transition or green bonds. When company has issued the specified bond, the dummy variable take a value of 1; otherwise, it takes a value of 0. By constructing two separate regression models for green and transition bonds, the coefficient β_1 associated with these variables offer valuable insight into the specific effects of each bond type on CO_2 emissions. This approach enables a detailed examination of the individual impacts of these two type of bonds, fostering a comprehensive understanding of their effectiveness in advancing environmental goals and sustainable finance practices.

4.1 Control variables

4.1.1 Energy intensity

In evaluating the energy intensity of different industries, various factors were considered, including the energy required to generate a unit of output or provide a specific service within a particular sector. Industries characterized by high energy intensity consume larger quantities of energy per unit of production, whereas those with low energy intensity require less energy for same level of output. Considering these factors, the following numerical values were assigned, ranging from 1 (the lowest energy intensity) to 6 (the highest energy intensity), to each industry included in this research:

- *Energy and Technology* – given the nature of the industry, this sector is typically associated with high energy consumption. The development and operation of advanced technologies often require substantial amounts of energy. Therefore, a value of 6 is assigned to indicate the sector's high energy intensity.
- *Chemicals and Materials* – the manufacturing and processing of chemicals and materials frequently involve energy-intensive processes. These industries typically require significant amounts of energy for activities such as heating, cooling, and chemical reactions. As a result, a value of 5 is assigned to indicate their relatively high energy intensity.
- *Heavy Machinery* – the production and operation of heavy machinery involve energy-intensive processes such as manufacturing, assembly, and usage. Considering these factors, heavy machinery is considered to have a moderate energy intensity, resulting in a value of 4 being assigned to represent it.
- *Shipping and Maritime* – this industry relies on energy for propelling vessels and transporting cargo. Despite beige one of the vital sectors for global trade, the energy consumption linked to these activities is considered moderately high. Hence, a value of 4 is assigned to reflect the industry's energy intensity.
- *Airline* – airlines require significant energy consumption for various aspects of their operations, including fuel for flights, maintenance, and ground operations. Despite being

crucial for global transportation, the airline industry exhibits a moderately high energy intensity. Therefore, a value of 4 is assigned to represent its energy intensity.

- *Road Operations* – road operations involve transportation via road networks, including various vehicles. While energy is consumed within this sector, the overall energy intensity is considered moderate compared to other industries. Therefore, a value of 3 is assigned to reflect its energy intensity.
- *Distribution (gas)* – the distribution of gas involves activities such as transportation and storage. While these operations require energy, the energy intensity is generally moderate. Hence, a value of 3 is assigned to represent the energy intensity within this sector.
- *Logistics and Real Estate* – logistics and real estate, in comparison to the other industries examined in this study, exhibit a relatively lower energy intensity. While energy may be consumed in transportation, storage, and building operations, it tends to be less significant. As a result, a value of 2 is assigned to indicate the sector's relatively lower energy intensity.

4.1.2 Pandemic impact

When assessing the influence of the COVID-19 pandemic on various industries, it is important to consider the specific impacts and disruptions caused by the global health crisis. Considering the extensive impact observed, numerical values ranging from 1 (the lowest influence) to 6 (the highest influence) had been assigned to each industry included in this research:

- *Energy and Technology* – the COVID-19 pandemic had a high influence on this sector. The industry experienced significant disruptions in energy demand, supply chain, and technology investments. With the economic slowdown and changes in energy consumption patterns, a value of 5 is assigned to represent the substantial influence.
- *Chemicals and Materials* – this industry faced significant disruptions during pandemic. Supply chain were affected and there were shifts in demand for certain products. Considering these factors, a value of 4 is assigned to represent the notable influence on this sector.

- *Heavy Machinery* – this industry experienced moderate influence from the COVID-19 pandemic. While there were disruptions in production and changes in demand, the sector was not as severely impacted as others. Hence, a value of 3 is assigned to reflect the moderate influence on this industry.
- *Shipping and Maritime* – this industry encountered substantial challenges due to disruption in global trade and logistics. With restriction on international transportation and changes in demand, the influence of the pandemic on this industry was significant, warranting a value of 4.
- *Airline* – the airline industry was one of the most severely affected by the pandemic. With travel restrictions, lockdown measures, and reduced demand for air transportation, the influence on this industry was exceptionally high. Therefore, a value of 6 is assigned to represent the significant impact on airlines.
- *Road Operations* – road operations industry faced moderate influence during pandemic. While changes in transportation patterns and restriction affected the sector, it was relatively more resilient compared to industries heavily reliant on air travel or international logistics. Thus, a value of 3 is assigned to represent the moderate influence.
- *Distribution (gas)* – this industry experienced relatively lower influence from the COVID-19 pandemic. As gas distribution remained essential, though with operational adjustments, the impact was not as severe as in other sectors. Therefore, a value of 2 is assigned to represent the relatively lower influence on this industry.
- *Logistics and Real Estate* – this industry saw moderate influence from the pandemic. With changes in supply chains, fluctuations in demand, and the impact on commercial real estate, the sector was moderately affected. Thus, a value of 3 is assigned to represent the moderate influence eon logistics and real estate.

4.1.3 Regulatory compliance

When evaluating the level of government interaction, restriction, initiatives and influence in mitigating climate change, several factors were considered. These factors included the extent of government policies, commitments, investments, and the overall perception of international efforts. Based on these considerations, the following numerical values were assigned, ranging from 1 (the lowest governmental engagement) to 6 (the highest governmental engagement), to each country included in this research:

- *United States* – The United States is assigned a value of 3, indicating a moderate level of government integration, initiatives, and influence in climate change mitigation. While the country has experience fluctuation in policies and commitment levels over time, it has implemented certain initiatives and engaged in international climate agreements.
- *Japan* – Japan is assigned a value of 4, signifying a relatively high level of government interaction, initiatives, and influence in climate change mitigation. The country has placed a strong focus on renewable energy development, technological advancements, and has made commitments to reduce greenhouse gas emissions.
- *Norway* – Norway received a value of 5, indicating a significant government integration in climate change mitigation. The country has demonstrated a strong commitment to renewable energy, emission reduction, and sustainable practices. It has implemented various policies and invested significantly in green technologies.
- *China* – China is assigned a value of 3, representing a moderate level of government integration. China has made significant investment in renewable energy sources and has set targets for emission reduction. However, challenges remain due to country's high emissions from industry.
- *South Korea* – South Korea also receives a value of 3, reflecting a moderate level of government interaction. The country has focused on renewable energy development and green technology advancement to reduce emissions and promote sustainable practices.
- *Italy* – Italy is assigned a value of 4, signifying a relatively high level of government interaction and initiatives in climate change mitigation. The country has committed to renewable energy, energy efficiency measures, and emission reductions. It has implemented various policies and participated actively in international climate agreements.
- *Germany* – Germany received a value of 5, indicating significant government integration. The country has shown strong commitment to renewable energy, energy transition, and

ambitious climate targets. I t has implemented comprehensive policies and has been a leader in promoting renewable energy development.

4.2 Construction of sample

To construct the sample of green and transition bonds, several steps were followed. Starting with a pool of 55 transition bonds issued between years 2019 and 2022, bonds without a maturity date were removed to avoid potential issues when matching transition bonds with corresponding green bonds. After this elimination, 54 transition bonds remained. Next, transitions bonds that were issued simultaneously with green bonds and share same issuer where removed to avoid double influence, resulting in 27 remaining bonds. The bonds issued by Unity 1 and Candent Finance had to be excluded due to their issuers' role in providing financial services to other companies, including issuing these bonds on behalf of other companies. Hence, gathering data on the CO_2 emissions influenced by these specific bonds would be impractical or almost impossible. This elimination reduced the number of remaining bonds to 24. Furthermore, the bonds issued by JERA Co Inc also had to be excluded due to its status as a joint venture between two Japanese companies, Tokyo Electric Power Company Holdings (TEPCO) and Chubu Electric Power Company. This joint venture structure makes it extremely challenging to obtain data that pertains exclusively to JERA Co Inc. This left a total of 22 transition bonds.

Moving on to the green bonds, a pool of 4,985 bonds issued between years 2019 and 2022 was considered. Similar to the transition bonds, bonds without maturity date were eliminated, resulting in 4,820 green bonds. To avoid double influence, green bonds issued simultaneously with transition bonds and share the same issuer were also removed. This further reduced the count to 4,626 green bonds. The final step involved matching the remaining 22 transition bonds with 22 green bonds based on several criteria. The most important criterion was the industry in which the entities that issued this bonds operate. Additionally, factors such as geographical area, issuance date, and the amount issued were considered for the matching process. Through the implementation of these steps, a sample comprising 22 transition bonds and their corresponding 22 green bonds was successfully generated. Their sample represents a total of 44 bonds issued by 28 distinct issuers.

4.3 Descriptive statistics

The analysis focuses on the change in emissions, which is measured in percentage units. The emission values for the year before issuance and the year of issuance are both expressed in metric tonnes of CO_2 equivalent. The percent change is determined by subtracting the emissions value of the year before issuance from the emissions value of the year of issuance. The difference is then divided by the emissions value of the year before issuance and multiplied by 100 to obtain the percent change. This methodology enables an evaluation of the relative increase and decrease in emissions over specific time periods using a standardized percentage metric.

Descriptive statistics play a crucial role in providing insights into the characteristics and patterns of the data under study. They aid in summarizing, analyzing, and interpreting the percent change in emissions as well as the effects of green and transition bonds. The descriptive statistics employed in this chapter include various measures such as mean, median, standard deviation, sample variance, kurtosis, skewness, minimum, and maximum. By examining these statistics, a comprehensive understanding of the distribution, central tendency, dispersion, and shape of the data can be attained.

Table 4.1: Summary statistics of change in CO_2 emission for green and transition bonds from 2019 to 2022 (total number of observations 44)

	Green Bonds	Transition Bonds
Mean	-1.31%	105.78%
Median	-1.11%	3.99%
Standard Deviation	16.57%	334.87%
Sample Variance	2.75%	1 121.36%
Kurtosis	-3.48	-3.40
Skewness	-0.01	0.30
Minimum	-22.28%	-12.77%
Maximum	57.48%	1 139.73%

The mean indicates the average change, with green bonds showing an average decrease of -1.31% and transition bonds exhibiting an average increase of 105.78%. The median represents the middle value, where green bonds have a median of -1.11% and transition bonds have a median of 3.99%. The standard deviation measures the spread of the data, with green bonds showing a moderate variability of 16.57% and transition bonds displaying a higher variability of 334.87%. The sample variance confirms these patterns, with green bonds at 2.75% and transition bonds at 1 121.36%. The kurtosis indicates a platykurtic distribution for both categories (-3.48 for green bonds and -3.40 for transition bonds), suggesting flatter tails and fewer extreme values. The skewness is slightly negative for green bonds (-0.01) and slightly positive for transition bonds (0.30), indicating some asymmetry. The minimum and maximum values show the range of observed changes, with the largest decrease pf -22.28% for green bonds and the largest increase of 57.48% for green bonds, while for transition bonds, the largest decrease is -12.77% and the largest increase in 1 139.73%. These descriptive statistics provide a concise summary of the percent change in emissions, capturing central tendencies, variability, distribution shape, and range of values across the different bond categories.

5 RESULTS AND ANALYSIS

5.1 Regression analysis

Regression analysis is a statistical techniques that explores and quantifies the relationship between a dependent variable (change in CO_2 emissions) and one or more independent variables (issuance of green and transition bonds). By estimating coefficient and assessing their significance, regression analysis helps uncover patterns, make predictions, and examine how changes in the independent variable relate to changes in the dependent variable.

The first model focuses on analyzing the impact of green bonds on the reducing CO_2 emissions and advancing sustainable finance practice:

$$\Delta\, CO_2\ emissions = \beta_0 + \beta_1 * green\ bond + \beta_2 * energy\ intensity + \beta_3 * regulatory\ compliance + \beta_4 * pandemic\ impact + \varepsilon$$

The findings indicate that the coefficient for green bonds is negative (-1.1672), implying that issuance of green bonds is associated with a decrease in CO_2 emissions. However, it is important to note that this effect is not statistically significant at the conventional significance level ($p = 0.1100$). The analysis also considered other variables such as energy intensity, pandemic impact, and compliance regulation. These variables showed non-significant coefficients, indicating that they do not have a statistically significant impact on the change in CO_2 emission. The overall model's goodness of fit is relatively low, with a R-squared value of 0.1558, suggesting that only 15.58% of variation in the CO_2 emissions can be explained by the included independent variables.

The second model examines the impact of transition bonds on the pursuit of environmental goals by understating their contribution to mitigating CO_2 emissions:

$$\Delta\, CO_2\ emissions = \beta_0 + \beta_1 * transition\ bond + \beta_2 * energy\ intensity \\ + \beta_3 * regulatory\ compliance + \beta_4 * pandemic\ impact + \varepsilon$$

When it comes to transition bonds, the findings indicate that the coefficient for transition bonds is positive (1.1672), implying a potential positive impact in order words increase in CO_2 emissions. However, it is important to note that this effect is not statistically significant at the conventional significance level. None of the control variables showed a statistically significant impact on the change in CO_2 emission, as indicated by their non-significant coefficients.

5.2 Hypotheses tests

Based on the results of the regression analysis conducted to test the first hypothesis, which examines the impact of green bonds on reducing CO_2 emission, the findings align with previous studies in the literature. These studies have indicated that the effectiveness of green bonds in supporting companies' environmental objectives is limited. Considering this, it is reasonable to expect that the issuance of green bonds may have a minimal or insignificant impact on reduction of CO_2 emission for the specific company or government being analyzed.

H1. The issuance of green bond has insignificant impact on reducing the CO_2 emissions.

H1a. The issuance of green bond has significant impact of reducing the CO_2 emissions.

The coefficient estimate for the green bonds is -1.1282. This indicates that, on average, there is a decrease of 1.1282 units in CO_2 emissions associated with the issuance of green bonds. The standard error for the coefficient estimate is 0.7157 suggesting some uncertainty in the estimate. The t-value for the coefficient is -1.576 which indicates the magnitude of the coefficient relative to its standard error. In this case, the t-value is negative, suggesting a negative relationship between the issuance of green bonds and CO_2 emission. The p-value associated with the coefficient is 0.1224. This p-value represent the probability of observing a coefficient as extreme as the one estimated, assuming there is no true relationship between the issuance of green bonds and change in CO_2 emissions. Since the p-value (0.1224) is greater than the conventional significance level (e.g., 0.05), there is not enough evidence to reject the null hypothesis. Therefore, it can be concluded that the issuance of green bonds has an insignificant impact on reducing CO_2 emissions based on the current data. The R-squared value (0.0559) indicates that approximately 5.6% of the variation in CO_2 emissions can be explained by issuance of green bonds. The adjusted R-squared value (0.0334) account for the number of predictors in the model and suggest that green bonds has limited explanatory power for CO_2 emissions. Overall, the results suggest that while there is a negative relationship between the issuance of green bonds and CO_2 emissions, it is not statistically significant.

Based on the intended objective and the role transition bonds play in supporting the shift from a fossil fuel-dependent economy to one with reduced carbon emissions, it is expected that transition bonds would have a positive impact on reducing CO_2 emissions. However, the results of the regression analysis indicate that the coefficient for transition bonds is positive, suggesting a connection between the issuance of transition bonds and an increase in CO_2 emissions. This finding is contrary to expectations and raises question about the effectiveness of transition bonds in achieving their intended environmental objectives.

H2. The issuance of transition bond has positive impact on reducing the CO_2 emissions.
H2a. The issuance of transition bond has no positive impact on reducing the CO_2 emissions.

The coefficient estimate for the transition bonds is 1.1282. This indicates that, on average there is an increase of 1.1282 units in CO_2 emissions associated with the issuance of transition bonds. The standard error for the coefficient estimates is 0.7157, suggesting some uncertainty in the estimate. The t-value for the coefficient is 1.576, which indicates the magnitude of the coefficient relative to its standard error. In this case, the t-value is positive, suggesting a positive relationship between the issuance of transition bonds and CO_2 emissions. The p-value with the coefficient is 0.122. This p-value represents the probability of observing a coefficient as extreme as the one estimated, assuming there is no true relationship between the issuance of transition bonds and CO_2 emissions. Since the p-value (0.122) is greater than the conventional significance level (e.g., 0.05), we do not have enough evidence to reject the null hypothesis. Therefore, we conclude that the issuance of transition bonds has a statistically insignificant impact on increasing CO_2 emission on the current data. The R-squared value (0.0559) indicates that approximately 5.6% of the variation in CO_2 emission can be explained by the issuance of transition bonds. The adjusted R-squared value (0.0334) account for the number of predictors in the model and suggest that transition bonds has limited explanatory power for CO_2 emissions. Overall, the results suggest that while there is a positive relationship between the issuance of transition bonds and CO_2 emissions, it is not statically significant.

5.3 Heteroskedasticity

5.3.1 Breusch-Pagan Test

The scientized Breusch-Pagan test was used to examine heteroskedasticity in two regression models – one with green bonds and one with transition bonds. The results of the test were identical for both models. The test statistic (BP) was calculated to be 6.0707, with 4 degrees of freedom (df). The associated p-value for the test was found to be 0.1939.

Based on these results, there is no strong evidence to reject the null hypothesis of homoscedasticity. The p-value is greater than the chosen significance level, suggesting insufficient evidence to conclude that heteroskedasticity is resent in either the model with green bonds or the model with transition bonds.

5.3.2 White's Test

The White's Test, or Non-constant Variance Score Test, was conducted to assess heteroskedasticity in the regression models. The test was performed separately for the model with green bonds and the model with transition bonds.

The test statistic measure overall fit of the model in relation to the variance of the residuals. A larger test statistic indicates a higher likelihood of heteroskedasticity (44.1011). The degrees of freedom represent the number of restriction in the model. In this case, df = 1 indicates that the test is based on one restriction. The p-value represents the probability of obtaining the observed test statistics (or more extreme value) if the null hypothesis of homoskedasticity is true. In both cases, the p-value is very close to zero (3.1185e-11), which is significantly smaller than the conventional significance level of 0.05. Based on these results, there is strong evidence to reject the null hypothesis of homoskedasticity. The extremely low p-value suggests that heteroskedasticity is likely present in both model. This indicates that the variance of the residuals is not constant across different level of predictors.

5.3.3 Residual plot

When assessing heteroskedasticity in the residual plots for both green and transition bonds, certain patterns were observed, suggesting the existence of unequal variances in the errors.
In the green bonds model, a noticeable observation is that the spread of residuals appears flatter compared to the regression line. This suggests that the variability of the errors is not consistent across range of predicted values. As the predicted values increase, the spread of residuals remains relatively constant rather than narrowing. This indicates that the error variance is not constant and changes as the predicted values change, indicating the presence of heteroskedasticity.

Similarly, in the transition bond model, the residuals also display a flatter spread of residuals compared to regression line. This implies that the variability of the errors is not uniform across the predicted values. The spread of residuals does not decrease or increase consistently with the predicted values, indicating heteroskedasticity. Overall, the flatter spread of residuals in both models indicates that the assumption of constant error variance is violated. The presence of heteroskedasticity in models suggests that the reliability of the coefficient estimates and the validity of statistical inferences may be affected.

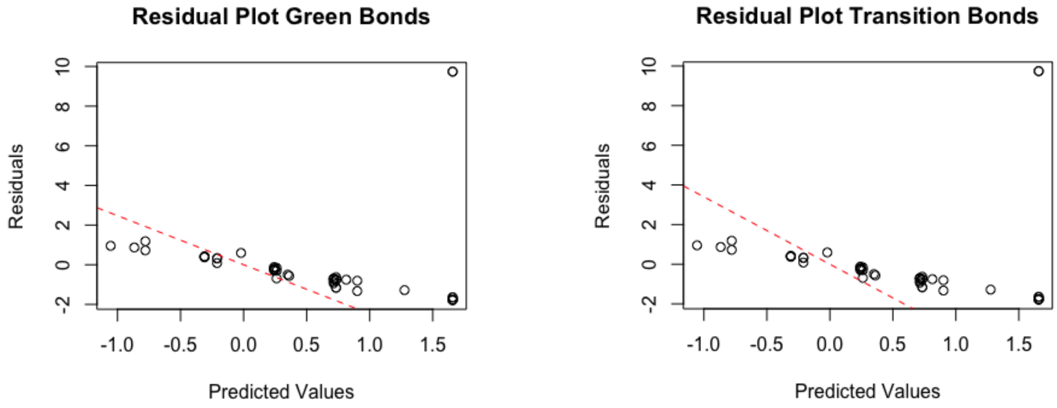

Figure 5.1: Residual plots for green and transition bond models

5.3.4 Conclusion

Despite the presence of heteroskedasticity in 2 out of 3 tests conducted, no immediate actions will be takes due to contextual considerations. While heteroskedasticity suggest that the assumption of constant error variance is violated, it is important to consider the broader context of the analysis.

In this particular study, the heteroskedasticity may not significantly impact the overall findings or conclusions. Therefore, based on the contextual consideration and the nature of the research, it has been determined that the heteroskedasticity observed in the tests does not warrant immediate action. However, it is essential to acknowledge the presence of heteroskedasticity and its potential impact on the reliability of coefficient estimates and statistical inference. Future studies may explore alternative regression techniques or robust methods to address the issue more effectively.

6 CONCLUSION

This research aimed to investigate the effectiveness of green bonds and transition bonds in facilitating the reduction of CO_2 emissions. Through the analysis of regression model and hypothesis testing, several finding have emerged.

First, the results of the regression analysis revealed that the issuance of green bonds has an insignificant impact on reducing CO_2 emission. The coefficient associated with green bonds was found to be statistically non-significant, suggesting that the use of green bonds may not be robust mechanism for achieving significant reduction in emissions. This finding aligns with previous studies in the literature, which have indicated limited effectiveness of green bonds in facilitating environmental goal realization.

Secondly, the analysis also examined the influence of transition bonds on CO_2 emissions. Surprisingly, the coefficient associated with transition bonds was positive, indicating a potential increase in CO_2 emissions rather than a reduction. However, the statistical significance of this coefficient was not established.

Furthermore, diagnostic test for heteroskedasticity were conducted on both the green bonds and transition bond models. Despite the presence of heteroskedasticity in 2 out of 3 tests conducted, the decision not to take immediate actions is based on contextual considerations. Based on these findings, it can be inferred that the issuance of green bonds may have limited effectiveness in achieving significant reduction in CO_2 emissions. Additionally, the unexpected positive coefficient for transition bonds warrants further exploration and consideration of potential factors influencing CO_2 emissions in the context of transition bonds.

It is important to acknowledge that this research has certain limitation, the study focused on a specific context and sample, and the findings may not be generalizable to other industries and regions. Additionally, other factors beyond the scope of this research, such as policy frameworks and technological advancements, could also influence the impact of green bonds and transition bonds on CO_2 emissions. Overall, this research provides insights into the potential limitations and complexities associated with using green bonds and transition bonds as mechanisms for achieving environmental goals. Further research and analysis are needed to gain a comprehensive understanding of the effectiveness of these financial instruments and to explore alternative strategies for addressing CO_2 emissions and promoting sustainable development.

7 BIBLIOGRAPHY

Bukhari, S. A. H. (2011) *What is a comparative study?* SSRN. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1962328

Cermeno, N. (2022). *Transition Finance – It's not enough to just invest in green.* Baringa https://www.baringa.com/en/insights-news/blogs/july-2022/transition-finance-investing-beyond-just-green/

Duteil, H. (2019). *Sustainable Finance - It's all about transition.* BNP Paribas. https://www.environmental-finance.com/content/analysis/sustainable-finance-its-all-about-transition!-part-one.html

G20 Green Finance Study Group. (2016). *G20 Green Finance Synthesis Report*. http://www.g20.utoronto.ca/2016/green-finance-synthesis.pdf

Kaminker, C., Youngman, R. & Buckle, S. (2017). *Mobilising bond markets for a low-carbon transition.* https://doi.org/10.1787/9789264272323-4-en

Lichtenberger, A., Braga, J. P. & Semmler, W. (2022). *Green bonds for the transition to a low-carbon economy.* Econometrics. https://www.mdpi.com/2225-1146/10/1/11

Riordan, R. (2019). *Transition bonds.* Institute for Sustainable Finance. https://smith.queensu.ca/centres/isf/resources/primer-series/transition-bonds.php

Riordan, R. (2021). *Green bonds.* Institute for Sustainable Finance. https://smith.queensu.ca/centres/isf/resources/primer-series/green-bonds.php

Tuhkanen, H. & Vulturius, G. (2020). *Are green bonds funding the transition? Investigating the link between companies' climate targets and green debt financing.* Journal of Sustainable Finance & Investment. https://www.tandfonline.com/doi/full/10.1080/20430795.2020.1857634

United Nations. (n.d) *The Paris Agreement* https://unfccc.int/process-and-meetings/the-paris-agreement

Vulturius, G., Maltais, A. & Forsbacka, K. (2022). *Sustainability-linked bonds – their potential to promote issuers' transition to net-zero emissions and future research direction.* Journal of Sustainable Finance and Investment. https://www.tandfonline.com/doi/epdf/10.1080/20430795.2022.2040943?needAccess=true&role=button