



The Equity Market Reaction to Corporate Climate Action Bond Issue Announcements

Tarah Chetty

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Student number	CHTTAR008
Student name	Tarah Chetty
Signature of Student	Signed by candidate
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ABSTRACT

Climate change has become the defining crisis of our time. Without drastic action today, adapting to the future impact of this issue will be both challenging and costly. Green bonds enable capital-raising and investment for projects that have a positive impact on the environment, facilitating the mobilisation of financial resources for projects to combat climate change. This study is the first bond issue announcement investigation to adopt a United Nations Sustainable Development Goals lens, specifically focusing on SDG 13: Climate Action, to investigate the market reaction to a global sample of 276 corporate climate action bond issue announcements between the inception of the green bond market in 2007 and 2022. Firstly, an event study is conducted to assess the equity market's reaction to corporate climate action bond issue announcements, and secondly, a regression is used to investigate possible factors correlated with the magnitude of the market reaction both on the announcement date, as well as over ten days thereafter. The factors tested against the cumulative excess returns in the second part of the study are the size of the issuer, whether the issue is a first-time climate bond issue for the company or not, the issuing company's ESG, environmental, and governance disclosure scores, the profitability of the issuing firm and the Environmental Performance Score (EPI) of the country in which the issuing company's equity is listed. The study finds that green bonds yield positive announcement abnormal returns on the announcement day, but that cumulative abnormal equity returns follow a downward trend over the subsequent 10 days. Further, the profitability of the issuing firm and whether the issue is the first climate change bond issued by a company or a subsequent issuance, are found to be positively and negatively correlated, respectively with some statistical significance to the ten-day cumulative abnormal returns. Thus, post-announcement the shares of companies announcing green bond issues underperform on a risk-adjusted basis, which could indicate that on average the market is not convinced that the proceeds of these green bonds will be well used. Thus, they may not be effective in closing environmental investment gaps as is intended, which could indicate that the issuers of these bonds have to do more work to convince the market of their use.

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CHAPTER 1: INTRODUCTION AND BACKGROUND

1.1.BACKGROUND

Climate change is considered by many to be the defining issue of our time. It threatens communities and economies and poses risks for agriculture, food and water supplies. The failure to address and adapt to climate change is "the most impactful" risk confronting communities globally, surpassing even the threat of weapons of mass destruction and water shortages, according to the World Economic Forum's 2021 Global Risks Report (World Economic Forum, 2021). Because of its ability to cause natural disasters, environmental degradation and extreme weather conditions destroying harvests, fisheries and livelihoods, while spurring infectious diseases, climate change has also been called a "threat multiplier". A desperate race for scarce natural resources can result from the loss of land and livelihoods, which can exacerbate social tensions in an environment of ongoing poverty, relocation, and other uncertainties (United Nations, 2017). Its impact is global in scope and unprecedented in scale.

Analysts have estimated that it could cost up to USD (United States Dollar) 50 trillion over the next two decades to combat climate change (Ali, 2021). While this appears to be an impossibly daunting figure, a possible part of the solution to financing this gap lies in one of the more prominent innovations in the sustainable finance space – green bonds. Green bonds are typically structured in the same way as conventional investment grade bonds, with the exception that the bond has a "use of proceeds" clause, stating that the financing will be earmarked for environmentally friendly projects (Climate Bonds Initiative, n.d.a). These bonds address key areas of environmental concern, such as climate change, natural resource depletion, loss of biodiversity, and air, water or soil pollution, and are the first debt instruments to contribute to the environmental sustainability of business operations.

Over the past ten years, the development of green bonds and the growth of the green bond market has been a significant advancement within the area of finance. The first green bond was issued in 2007. However, the market only started gaining momentum and popularity in 2014 and has since closed each year at all-time highs. This market has the potential to become a multi-trillion-dollar market within the next decade, providing society with the much-needed tools to address climate change. It has grown at an exponential rate, reaching its most significant milestone in December 2020, with USD 1 trillion in cumulative issuance since

market inception in 2007 (Climate Bonds Initiative, n.d.a). Further, in the 13 years since inception, the average annual growth rate was calculated to be approximately 95%, with the US (United States), China and Germany being the leading countries in terms of issuance. While this market only accounts for less than 1% of the total global bond market, issuance has grown rapidly (Climate Bonds Initiative, n.d.a). However, despite significant growth, academic research on green bonds has been very limited.

The finance and investment sectors have become a key arena for economies accelerating the transition to both sustainability and climate neutrality¹ – likely due to there being countless avenues in which they interact. Investors are increasingly curious about the environmental elements within their investments due to the fact that it has become practically impossible to ignore the conversation around climate change and environmental concern, coupled with a newfound sense of urgency resulting from an increase in climate-related natural disasters. Within this context, environmental, social and governance (ESG) factors have become of particular importance. This refers to criteria that are used to screen investments based on corporate policies that encourage companies to act in a responsible manner. Investors are therefore looking for a better understanding of how ESG dimensions impact the financial performance of assets, more transparency on which companies are financing unsustainable economic activity and finally, the impact of their investment, and whether it is socially responsible or not (Maltais, 2020). In addition to this, concerns about climate policy and climate impact risks, as well as unsustainable business practices leading to stranded assets have arisen, thereby further linking these sectors (Maltais, 2020).

Moreover, there are now several active initiatives focused solely on ensuring the finance sector's contribution to achieving sustainability. These include the Financial Stability Board's Task Force on Climate-related Financial Disclosures, the United Nations Principles for Responsible Investment, and the European Commission's ongoing Action Plan on Sustainable Finance (Maltais, 2020). Studies have further suggested that sustainable investment reflects a concern with the community and the environment. It is an active system for the proper

¹ Climate neutrality refers to the idea of achieving net zero greenhouse gas emissions by balancing those emissions so they are equal, or less than, the emissions that get removed through the planet's natural absorption (United Nations Climate Change, 2021).

assignment of resources across all parts of the investing universe, not a concept that solely refers to culture (Carolina Rezende de Carvalho Ferreira et al., 2016).

The finance and investment sectors play a significant role both in allocating capital efficiently, as well as in attempting to fulfil the need to gather a relatively large amount of private capital in order to meet the investment needs required to achieve the climate targets of the Paris Agreement of the Sustainable Development Goals (SDGs) (Maltais, 2020). The SDG's are an integrated framework of human, social and environmental development objectives, including 17 goals with 169 targets and 232 specific indicators, that were adopted by the United Nations in 2015 as a universal call to action to end poverty, protect the planet and ensure that by 2030 all people enjoy peace and prosperity (United Nations Development Program, n.d.). They have been widely used in national development plans, academic research and foreign aid prioritisation (Moyer & Hedden, 2020). Further, action in one area will affect outcomes of others, and it is vital that any development balances social, economic and environmental sustainability.

With 2030 approaching exponential momentum is needed to achieve these goals to remain on track to meet the desired deadline. At the United Nations Global Compact CEO's round table held in New York in 2019, the UN Deputy Secretary General stated that attaining the SDG's by 2030 will be impossible at the prevailing investment rate, which currently leaves a USD 2.5 trillion annual SDG investment gap (United Nations, 2019). It is therefore becoming increasingly important to resolve the problem of financing SDG programmes, and in this context green bonds have a key role to play in mobilising financial resources, while involving the private sector in the global effort to achieve the SDG's.

The focus of this study is SDG 13: Climate Action – to “take urgent action to combat climate change and its impacts” (United Nations Development Program, n.d.). It has been said that all SDG's are impacted by climate action, since climate change is a global issue impacting all countries and sectors, as explained above (Climate Bonds Initiative, 2018). While many of the SDG's have a social primary focus, it is crucial for a climate-resilient and mitigation lens to be applied on top of this in order to achieve these goals in a sustainable manner that is able to deliver positive impacts in both the medium and long term, and not just in the short term (Climate Bonds Initiative, 2018).

The Climate Bond Initiative's ongoing analysis of green bond investment found that six out of the seventeen SDG's accrued direct benefits through increased investment and growth in the green bond market, particularly in emerging market economies (Climate Bonds Initiative, 2018). SDG recipients include SDG 6: Clean Water and Sanitation, SDG 7: Affordable and Clean Energy, SDG 9: Industry, Innovation and Infrastructure, SDG 11: Sustainable Cities and Communities, SDG 13: Climate Action – the focus of this study – and, finally, SDG 15: Life on Land (Climate Bonds Initiative, 2018). It can thus be seen that the aforementioned goals fall into the environmental development category, which is expected, as the proceeds of this market are used to deliver *environmental* benefits, as well as a more sustainable economy.

Further, it must be noted that the rapidly growing green finance sphere already provides capital for assets that contribute specifically to SDG 13: Climate Action, along with many other SDG's. Since green bond investments can be increasingly integrated into these environmentally diverse goals, additional capital from institutional investors will likely be attracted.

Due to the importance placed on this specific goal, which can be considered the most important environmental goal, along with its strong influence and impact on other goals, an international sample of all climate action bond issue announcements from the green bond market's inception in 2007 until 2022 is examined in this study. From this, the market's reaction – and extent thereof – to the announcement of the issuance of climate action bonds, which directly affect SDG 13: Climate Action, is assessed, which assists global strategic decision making with regards to this goal and its associated timeline.

A climate action bond refers to a type of green bond that is issued in order to raise finance specifically for climate change solutions (Climate Bonds Initiative, n.d.b). Through issuing climate action bonds, the current annual SDG investment gap of USD 2.5 trillion can be decreased, thereby assisting in achieving this goal, along with many other SDG's.

While public sector contributions remain indispensable, they may be insufficient to meet the demands of all the SDG-related sectors (UNCTAD, 2014). However, the potential for increased private sector investment contributions is significant, especially in the infrastructure, food security and climate change mitigation sectors. As a result, this analysis focuses primarily on *corporate* sector climate action bonds (UNCTAD, 2014).

When analysing the issuance of corporate climate action bonds by publicly listed companies, the movement of their share prices on the day of issue announcement and subsequent period (or, more precisely, the abnormal returns associated with this), is a possible indicator of how investors view, among other things, green bond issuances. In the context of this study, this information is important due to the private sector specifically, playing a large role in closing the SDG funding gap. Whether the market views green bond issuances as positive or negative events directly influences the amount of attention, growth and funding that the green bond market will attract and further, has a large impact on the progression of several SDG's. The limited existing academic literature on stock market reactions to the issuance of green bonds seem to indicate a general positive market view (Flammer, 2021). However, this remains an area of study that is largely unexplored.

In investigating the economic implications of green bond financing, the literature has thus far focused on two main areas of research (Cheong & Choi, 2020). The first area relates to the market pricing of green bonds in both the primary and secondary markets. Academics have put forward the idea of a “greenium” – the price premium that investors are willing to pay for green bonds. The Investor Taste Theory states that the greenium should be positive due to investors being willing to pay more for green bonds and argues that they are willing to trade off wealth for societal benefits (Cheong & Choi, 2020). However, other studies show that the greenium should in fact be negative, due to green investing potentially not generating a positive net present value (Cheong & Choi, 2020).

The second main area of academic focus concerns the value implications for green bond issuers. Due to increased direct expenses from the certification procedure for green labelling, along with indirect costs from the restricted use of green bond profits, financing through green bonds is typically an expensive form of capital. Despite these costs, issuing green bonds has the potential to send an exceptionally positive signal to the market, indicating that the firm values long-term sustainable investing. However, due to the positive effects of the market perception of green financing that can increase short-term firm value, many firms can be incentivised to practise “greenwashing”, which is when the firm conveys a misleading picture of its commitment to green business practices and products to benefit from positive market perceptions (Cheong & Choi, 2020).

It is important to determine how the market reacts to the announcement of the issuance of green bonds as this largely affects their success in contributing positively to environmental initiatives, as well as closing the SDG funding gap. For this reason, an international sample of corporate climate action bond issue announcements is used within this study, in order to get a worldwide perspective on the market's reaction to these instruments.

While the market reaction to the announcement of green bond issuances is the core of this study, the determinants of this reaction are as important. Examining the relationship between variables of interest to determine which factors have a more significant influence on the magnitude of the market reaction, measured in the form of cumulative abnormal share returns (CAR's), is useful to better understand the drivers of the market's reaction. Through identifying these key factors, interested parties will be able to create products and procedures that will allow them to contribute to environmental sustainability in an effective and valuable manner. Within the context of the SDG's, identifying and using these factors strategically could assist in both accelerating the timeline of SDG 13: Climate Action, along with its related counterparts, and in growing the green bond market in a way such that it is able to ease a portion of the burden arising from the annual SDG investment gap mentioned before.

1.2.PROBLEM STATEMENT

The focus of this study is firstly to analyse the equity market's reaction to the announcement of a climate action green bond issuance. Factors that potentially play a role in whether the market reaction to a specific green bond announcement is positive or negative include the view on whether the associated investments are likely to be value creating or value destructive, as well as investors' broader belief (or not) in the principles of sustainable investing. Specifically, if the equity market reacts negatively to climate action green bond issues, environmental progress in many different markets across the world could be hindered, including the environmental issues that the SDG's are trying to address.

The second part of this study is concerned with the factors that are correlated to the magnitude of the market's reaction as proxied by abnormal equity returns. This aspect of the study has the potential to provide significant insight, through identifying factors from the chosen variables that are correlated with the magnitude of the market's reaction to the announcement of a green bond issuance. This analysis may provide valuable information to investors that can be

advantageous within the trading process. This research is deemed relevant, interesting and important due to environmental issues becoming increasingly pressing, thus creating the need for active initiatives that contribute to achieving sustainability.

1.3.RESEARCH QUESTIONS

The two research questions addressed in this study are as follows:

Research Question 1:

How does the equity market react to the announcement of the issuance of climate action bonds?

Research Question 2:

Which variables are correlated to the magnitude of the abovementioned reaction?

1.4.NOVELTY AND CONTRIBUTION

Within the context of climate change, the green bond market and the SDG's, two broad questions form the basis of this study. Firstly, how does the market react to the announcement of green bond issuances and secondly, what are the key factors that are correlated to the magnitude of this reaction? In a broad sense, the proposed study aims to investigate the reaction of investors to the announcement of the issuance of all corporate climate action bonds issued globally, while simultaneously contributing to this new and under-researched field.

To the best of the author's knowledge such a study has not previously been conducted. Within Chapter 2, the only six studies that investigate the reaction of the market to the announcement of green bonds are analysed and discussed. Of these six, only one looked at climate bonds specifically, and none adopted an SDG perspective. Thus, a key feature that differentiates this research from others in the field is that it contributes to the existing literature on green bonds by being the first to analyse the market reaction, and the associated determinants, to green bond issuances through the lens of SDG 13: Climate Action, specifically, thus, providing a new and increasingly important perspective.

Further, this study introduces additional factors that may offer meaningful insights to the analysis. For example, as elaborated on in Chapter 2, Pederson and Thun (2019) found that certain countries within Europe exhibited a greater positive reaction than the rest of the continent. The proposed research furthers this finding through the inclusion of a proxy variable

for country-specific factors based on the Environmental Performance Index (EPI) (Environmental Performance Index, 2022), that rank 180 countries based on measures of environmental health and ecosystem vitality. This variable acts as an indirect measure of country specific culture with regards to environmental issues through offering a scorecard that highlights the leaders and laggards in terms of environmental performance. Through this, the value that investors place on these types of issues, which directly influences their reaction to the announcement of the issuance of a green bond, is inferred, thus deeming it a useful variable to include in the analysis.

Finally, the proposed investigation of the factors correlated with the magnitude of the equity market's reaction to the announcement of the issuance of climate-change related green bonds represent a further novel aspect of the present study. In order to adequately conduct this type of analysis, an event study is carried out, which is then followed by a regression analysis.

1.5. THESIS ROADMAP

The rest of this document is structured as follows. Firstly, Chapter 2 provides a literature review that summarises and highlights green investing, the Efficient Market Hypothesis and empirical findings relating to green bond announcements. Thereafter, Chapter 3 discusses the sample data and methodology used within the study, followed by Chapter 4 which reports and analyses the results of both the event study and regression analyses. Finally, Chapter 5 concludes.

CHAPTER 2: LITERATURE REVIEW

This chapter consists of three sections. Firstly, green investing and the Efficient Market Hypothesis (EMH) is discussed. This covers both the market reaction to green bond announcements, as well as how quickly that reaction takes place. Secondly, literature on the empirical findings relating to green bond announcements is presented. This provides insight into empirical evidence on the market reaction, along with its key drivers. Finally, the expected hypotheses for this study is presented for both the event study and regression analyses.

2.1.GREEN INVESTING

The concept of sustainable – or ESG – investing, as briefly mentioned above, is an approach to investing involving an investor taking cognisance of environmental, social and corporate governance (ESG) factors when allocating investment funds. The proposed market reactions that are applicable to this study fall into two parts. The first section focuses specifically on the environmental (E) factor of ESG investing through analysing green investing along with the associated market reaction, while the second section examines the nature of these reactions – or how quickly the market reacts. Both of these sections are discussed within this chapter.

When examining the factors driving the market's reaction specifically, this research pursues two main areas. The market could react in a positive manner because a) it believes that it is worth investing in green initiatives in order to promote sustainability, or b) it believes that these initiatives will deliver positive benefits to the issuing company through worthy performance. The opposite is true for that of a negative market reaction. Both areas are discussed below.

2.2.GREENIUM AND GREENWASHING

As mentioned in Chapter 1, the so-called “greenium” is the price premium that investors are willing to pay for green bonds that they would not pay for their non-green counterparts (Cheong & Choi, 2020). Greeniums, which are associated with lower bond yields, are induced either due to a prevalence of demand over supply, or by the belief that green investing generates positive benefits to society and is therefore worthwhile. One of the main focus areas within the limited financial literature examining the market's reaction to green bond financing are greeniums.

Several empirical and theoretical studies have documented investors willingness to trade wealth for societal benefits. Using US green and non-green bonds, Baker et al. (2018) discovered that securities with better environmental scores yield lower expected returns, which was interpreted as evidence of a positive greenium. Through examining a sample of bonds across the world, Zerbib (2019) found that green bond yields trade two basis points (bp) lower than their matched non-green counterparts, thus providing evidence of a positive greenium. Kapraun, Latino, Scheins and Schlag (2021) and Gianfrate and Peri (2019), on the other hand, focused specifically on the European market, finding a much higher greenium of fourteen and seventeen bps respectively. The findings of these studies suggest that green bonds are favoured both by the market for the benefits that they provide to society, as well as issuers, through serving as a convenient instrument even when accounting for the 0.1bp costs of earning a green label or rating.

Despite these findings, other studies argue the opposite. Investors may perceive green bonds as a relatively newer class of instruments, making them appear to be riskier or ambiguous. As a result, investor demand for green bonds may be weaker, which would result in higher yields associated with the green label, thereby suggesting the opposite of a greenium. In contrast to the findings of the authors mentioned previously, Karpf and Mandel (2017) found that green bonds trade at a yield of seven bps higher than that of their “brown” counterparts. This result was interpreted as investors finding greenness unattractive, or that they perceived added risk in green bonds, thereby requiring higher yields than that of conventional bonds for them to become tradeable. Bachelet, Becchetti and Manfredonia (2019) found similar results, but interpreted this deviation as a reflection of issuer characteristics or green verification – characteristics deemed essential in reducing informational asymmetries and avoiding suspicion of greenwashing.

Overall, the evidence in favour of and against the market paying a greenium based off the belief that green investments provide greater benefits, albeit societal as opposed to financial, is mixed. From this, it can be inferred that the market seems to be indifferent as to whether the bond is classified as “green” or not.

Other than increased risk and ambiguity, the above analysis does not find the market to have significant issues with green investing. To address the notion of investors associating green bonds with greater risk, one of the primary risks, the concept of greenwashing, is explored.

As mentioned in Chapter 1, greenwashing is considered to be an unsubstantiated claim to deceive consumers into believing that a company's products are environmentally friendly (Cheong & Choi, 2020). This also holds true for self-labelled green bonds, which frequently lack an institution or enforceable definition that ensures the efficacy and use of proceeds from such instruments. However, third party certification serves as one way to guarantee that bonds with a green label are used to finance environmentally friendly projects, thereby lessening the chance of greenwashing. Katori (2018) concentrated on the effects of this process and discovered that green bonds that have either attained green bond ratings from a rating agency or met the requirements of the climate bonds initiative (CBI) carry a lower premium than their brown counterparts, thereby indicating that investors perceive a lower level of risk associated with these bonds.

An alternate form of greenwashing is when a company directs only *part* of the proceeds collected from the bond toward green initiatives. It can be hypothesised that investors expect *all* proceeds to be directed towards these initiatives and thus, this presents a risk. Deng, Tang and Zhang (2019) confirmed this theory through carrying out a study exploiting a unique feature of Chinese green bonds, namely that the proceeds were only partially used for non-green projects. Any favourable premium that the green bond had in the overall sample was found to have vanished for the subsample of "browned-out" green bonds, and any notable pricing difference was found to be caused by the proceeds going *entirely* to green initiatives. These findings imply that investors are able to recognize greenwashing and that only bonds that are 100 percent green are granted any rewards that greenness delivers (Cheong & Choi, 2020).

Greenwashing has the potential to pose a considerable threat in terms of decreasing the market's willingness to invest in green bonds. It has led the market to question whether or not certain investments are green investments at all, which could induce investors into thinking that the process of green investing is not worthwhile. It can be seen from the aforementioned discussion that, dependent on the circumstances and general market sentiment, the market can perceive investing in green bonds as either worthwhile (whereby a greenium would be identified), or as a risky and ambiguous process, where the "greenness" of a bond is not certain and thus, has the potential to bring about negative consequences to the investing process.

2.3.PERFORMANCE OF GREEN INVESTING

In addition to the role played by greeniums and greenwashing, the reaction of the market to green bonds also depends on whether or not investors expect green initiatives to deliver positive returns to the company. When analysing the performance of green investing through looking at both outperformance and underperformance, it is important to distinguish between the short and long term. While the market may not react positively in the short term, the long-term performance and profitability of the company, coupled with some level of reversion to the intrinsic value, could result in future benefits.

The stock market generally underreacts to information regarding green investment strategies, meaning that initially the market does not properly realise the value implications of a positive green event (Hvidkjær, 2017). This is generally the main defence for the superior performance of green investing methods. As a result, the possibility for exceptionally large profits over time exists in organisations with such events, since they are frequently underestimated. Given the prevalence of stock market underreactions in numerous other scenarios, including post-earnings announcement drift (Ball & Brown, 1968) and momentum (Jegadeesh & Titman, 1993), both of which are two of the strongest arguments against market efficiency that are consistent with market underreaction, this hypothesis is plausible. Alternative hypotheses explore how the stock market undervalues certain intangibles, like green related-initiatives that possess a lower level of certainty, and that are less salient to investors. Evidence of this can be seen through underreactions to intangibles such as advertising, patent citations, R&D costs and software development costs (Hvidkjær, 2017).

An alternate argument for the outperformance of ESG stocks is that ESG investing has become increasingly popular in recent times. This surge in demand has the effect of pushing the prices of stocks that have a high ESG score up, even in the absence of new fundamental knowledge regarding their worth. Demand effects are therefore included in the theoretical arguments for why high ESG stocks may subsequently display underperformance (Hvidkjaer, 2017).

With regards to underperformance, it is also possible that the market believes that green investments provide the same, if not lower, value than that of their non-green counterparts through affecting the profits of a company in a negative manner. Alternatively, investors may not even be aware of such stocks, ignoring them altogether.

When many investors fail to take notice of specific stocks – e.g., stocks with a low green score – these stocks can potentially become undervalued. While initially implying low returns, these stocks will subsequently deliver high returns when compared to stocks with high green scores. The low stock price suggests a high dividend/price ratio and higher returns even if the undervaluation is permanent (Merton, 1987). Firms' responses, however, are not taken into consideration in the argument for pricing implications of the ignored stocks. Heinkel, Kraus and Zechner (2001) found that firms with stocks that have a low green score may respond to falling investor interest, which induces a lower stock price, by adjusting their behaviour, either through increasing expenditures in environmentally friendly projects, or by enhancing working conditions for staff.

For nearly perfectly elastic demand curves, stocks with a high green score were found not to overperform or underperform, as it is possible that green investing is not practiced widely enough to influence prices. However, even if this is the case, green investing may still have a negative financial impact on the individual investor for two reasons. Firstly, a fundamental principle of finance is that diversification reduces risk without lowering expected returns (Markowitz, 1959). As a result, the best risk-return trade-off comes from investing in a diverse portfolio of assets, with a worse trade-off resulting from any limitations on the universe of investable assets. Within this realm of research, in the absence of any pricing efforts, excluding firms in industries often shunned by green investors such as the tobacco and weapons industries, will induce these large lack-of-diversification effects (Hvidkjær, 2017).

Secondly, if screening comes at a high cost, low returns on green investments may still occur even in the absence of pricing impacts. For low-cost, passive investors, this problem is particularly pressing. Analysts argue that most investors should adopt this passive, low-cost strategy, which entails obtaining the least expensive exposure to an asset class, in light of the diversification argument, as well as the existence of a market that is almost informationally efficient. However, given that green investing entails picking certain stocks, it may not be compatible with this objective (Hvidkjær, 2017).

Thus, for perfectly elastic demand curves specifically, despite the market being willing to invest in green bonds either to promote sustainability or because it believes that they are financially worthwhile, these instruments may not provide the greatest financial benefits or be

included in an optimally designed returns-driven investment strategy, according to the principles of investing theory.

2.4.THE EFFICIENT MARKET HYPOTHESIS

As it is built around an event study, this research indirectly examines the efficiency of the market's reaction and hence considers a third element of the market reaction – in addition to whether the market reaction is positive or negative, as well as the magnitude of the reaction – namely the efficiency of the markets involved. As a result, the following section examines the nature of the market reactions – i.e. how quickly the market reacts to the announcement of green bond issues – through analysing the Efficient Market Hypothesis (EMH). According to the EMH, share prices respond rapidly and unbiasedly to all new and relevant price sensitive information. Fama (1970) proposed three forms of the EMH, namely the weak form, where the current prices of financial assets incorporate all existing *historical* information, thus, preventing investors from obtaining any abnormal profits; the semi-strong form, which assumes that financial assets' prices reflect all the information *existent within a market* including both historical prices and all current public information; and finally, the strong form, which assumes that prices incorporate *all* available information within a market, including historical financial information, all new public information and all the private information regarding a financial asset.

A large amount of research has been conducted to test all three forms of the EMH, with most invalidating the semi-strong and strong forms on the grounds of them not being supported by financial data (Titan, 2015). Opinions are split with regards to the weak form, with some studies finding that abnormal returns are mainly caused by chance, while others found that these kinds of anomalies tend to disappear as changes in models occur, thus attributing them to the research methodology used (Titan, 2015).

Most studies testing the EMH are based on event study methodology, which involves measuring excess market returns around the time of a specific announcements. Thus, the quicker financial asset prices react to new information, the more efficient capital markets are (Titan, 2015). Indeed, several studies have found quick market responses to new information, suggesting there to be a relatively high level of efficiency within capital markets, while having difficulty pinpointing the exact form of efficiency present. Other studies have examined longer

time horizons in an attempt to invalidate the EMH within the medium and long term, based on the fact that prices adjust gradually to the new information released (Titan, 2015).

When analysing event studies on daily data, a common finding is that, on average, stock prices appear to respond to certain event announcements within a day. This outcome has become so common that market efficiency is now only briefly discussed in this field of research, with studies shifting their attention to other problems after noting that rapid adjustment is associated with efficiency. In the only empirical study where the joint hypothesis problem² is rather unimportant, evidence consistently shows that, with regard to firm-specific events, the adjustment of stock prices to new information is efficient (Fama, 1991A).

In short, certain event studies imply that market prices do not react quickly to specific information. However, given the event-study boom of the last 20 years, some anomalies – spurious and real – are inevitable. Despite these findings, the main point is that event studies are the cleanest evidence there is on efficiency and according to Fama (1991), the market reacts relatively quickly to any kind of new information, including information related to green bonds.

In the next section, green bond literature is reviewed in order to determine what other authors have found when analysing the green bond market.

2.2. EMPIRICAL FINDINGS RELATING TO GREEN BOND ANNOUNCEMENTS

This study belongs to the pool of corporate finance literature that examines how the stock market reacts to the issue of securities – in this case, corporate climate action bonds specifically. Corporate green bonds are relatively new financial instruments that have experienced most of their growth within the past decade and as a result, little academic research exists on this topic.

The literature that is currently available on green bonds has primarily concentrated on bond pricing, as well as the differences in the cost of capital when green bonds are issued, as opposed

² The joint hypothesis problem states that when a model yields a return significantly different from the actual return, one can never be certain if there exists an imperfection in the model or if the market is inefficient (Fama, 1991A).

to conventional bonds (Pederson & Thun, 2019). Further, the vast majority of studies have investigated the “greenium” (outlined above), and whether it is positive, negative or zero – with most finding it to be positive (Pederson & Thun, 2019). While these studies provide valuable insights, they do not directly answer the question that this research poses. Recent literature, however, has started to investigate the markets’ reaction to the announcement of green bond issuances. The studies discussed below form the basis of the existing knowledge regarding this specific topic.

As stated in Chapter 1, how the market views the announcement of green bond issuances directly influences the amount of attention, growth and funding that the green bond market will attract. Further, this reaction will impact the progress in addressing of several SDG’s due to the role that the market plays in closing the SDG funding gap. Through examining studies conducted by other authors, different interpretations of this reaction can be explored that assists in providing a deeper understanding of the existing research on this topic.

Research by Flammer (2021), Tang and Zang (2020), Kuchin et al. (2019) and Wang et al. (2020) empirically investigated the market effects of green bond announcements. These studies examined the global green bond market, with the exception of Wang et al. (2020), who focused on the Chinese green bond market specifically. All four studies found that green bonds yield positive announcement returns, which suggests that these instruments could play a role in both advancing the growth of the green bond market and in closing the SDG funding gap. Flammer (2021) went on to state that additional benefits resulting from green bond announcements included improvements in operating and environmental performance, as well as long term firm value. These results were also found by Wang et al. (2020) within the Chinese green bond market and Kuchin et al.’s (2019) study, which is the only one, to the author’s knowledge, to include climate aligned bonds as part of the sample – albeit briefly. From this, it can be suggested that green investments contribute to firms in a positive manner which could further the market’s belief that they will provide greater returns than that of their non-green counterparts.

Wang et al.’s (2020) study established that the markets positive reaction came with a pricing premium on corporate green bonds relative to conventional bonds. Having examined the Chinese green bond market, it was found that the economic magnitude of this premium was much larger than that of international green bond premiums documented in other studies. These

results indicate the market's willingness to pay a premium for green bonds, thus indicating their worth. However, Tang and Zang (2020) failed to discover a consistent significant premium for green bonds but instead, found a significant improvement in stock liquidity subsequent to the firm issuing green bonds, which the other studies did not find. This suggests that adequate demand from buyers and sellers of green bonds exist within the market, thus inferring that these instruments possess a lower level of risk.

Glavas (2018) carried out a similar study, comparing equity investors' reaction to green bond announcements before and after the Paris Agreement – an international agreement from the 21st Conference of the Parties (COP) in the context of the United Nations Framework Convention on Climate Change (UNFCCC), adopted on the 12th of December 2015 – using a sample of all corporate green bonds issued globally between 2013 and 2018. This study found that the stock price reaction grew positively after said agreement, thereby suggesting a change in equity investor behaviour. This change can likely be attributed to an increase in awareness around the significance and urgency of climate change, thus inducing investors to value green investments more.

Despite the aforementioned studies all documenting positive value for equity holders from the announcement of the issuance of green bonds, some studies found evidence that the market reacts negatively to green bond issuances.

Through examining an international sample of corporate green bonds issuances, Lebelle, Lajili Jarjir and Sassi (2020) found that the market reacts negatively to the announcement of these issuances, with results showing the cumulative abnormal return to be between -0.5% and -0.2% depending on the asset pricing model used for the calculation. The proposed reason for this reaction was that green bonds signal increasing costs, due to incurring sizeable operational and capital expenditures that could be interpreted as a reduction in the future profitability of the firm (Lebelle et al., 2020). Finally, these authors document that this negative reaction is more prominent in developed markets, which can be viewed as a large problem due to investors within these types of mature markets – where global issues such as those to do with the environment should be prioritised – viewing the announcement of green bond issuances as negative events (Lebelle et al., 2020). Overall, their study suggested that green debt offerings convey unfavourable information about the issuing firms to the market.

Substantial disparities can be observed with regards to the findings across the aforementioned studies on the market's reaction to green bonds. This could be due to the fact that both the time period, as well as the number of years examined varies significantly between studies, with the largest and earliest time period studied being 2007-2019 by Kuchin et al. (2019) and the smallest and latest being 2016-2019 by Wang et al. (2020). Further, the number of bonds, countries and issuers used across studies also differs drastically with the highest figures being 780, 28 and 145, and the lowest being 95, 1 and 17 for the three, respectively. Thus, these differences may have contributed to the discrepancies in the results discussed above.

To the best of the author's knowledge, only the six studies analysed above have investigated the reaction of the market to the announcement of green bond issuances. Of these six, the study conducted by Kuchin et al. (2019) was the only one to consider climate bonds, while none of them adopted an SDG lens.

2.3. EMPIRICAL FINDINGS RELATING TO THE FACTORS RELATED TO THE MARKET'S REACTION TO GREEN BOND ANNOUNCEMENTS

The market reactions discussed above may be driven by certain key variables. Identifying which factors are correlated to the magnitude of the market reaction can provide valuable information to investors that can be advantageous within the trading process. Further, within the context of the SDG's, these factors can be used to reduce the burden of the SDG investment gap as well as accelerate the timelines of these goals. Identifying the key relevant variables can potentially be done through implementing a regression analysis. The regression model goes hand in hand with the event study methodology and is fundamental to understand i) which variables are significant for the description of the dependent variable and ii) the impact that these variables have on the CAR value (Pederson & Thun, 2019). The studies presented below represent the foundation for what is currently known about the impact of certain key variables on the market's reaction to green bond issuances.

The only event studies that appear to have used regression model methodologies on green bond issues are those of Pederson and Thun (2019) and Baulkaran (2019). The factors included in the regression analysis of the study conducted by Baulkaran (2019) explained approximately 33% of the variation in CAR, compared to that of Pederson and Thun's (2019) study, which only explained 22%.

It is suggested that the market values large, growing firms that issue green bonds higher compared to that of their counterparts, as these firms will likely be seen as reliable candidates that will have a higher rate of success. Baulkaran (2019), who focused specifically on green bond announcements in the European stock market from November 2013 to October 2019, found that firm size, Tobin's Q (used as a proxy for growth opportunities) and growth of the companies were positively related to the cumulative abnormal returns (CARs) of his event study, thereby confirming this theory. In addition to the firm specific variables outlined above, softer, bond specific elements were also explored. For example, the global study of the stock market reaction to green bond issuances conducted by Pederson and Thun (2019), concluded that the green label of the bond had a significant positive impact on firm value for companies, thus confirming the validity of the green label as a potential variable. Within the context of the present study, third party certification was considered as a potential variable. However, only three bonds in the corporate climate action bond data sample were certified, thereby making the variable inviable due to a lack of sample variation.

Pederson and Thun's (2019) study further found evidence supporting the notion that shareholders benefited each time a green bond was announced – not just the first time, thus deeming the “fundamental channel” a potential driver for the positive stock market reaction. Finally, through investigating regional differences, it was discovered that markets in Northern Europe exhibited higher returns than the rest of the continent.

It must be noted that few green bond studies use this specific methodology, which is more established in the literature on bonds in general. Green bonds are merely a specialised form of bonds and thus, the same methodology that is applied to bonds in general can also be applied to green bonds and still be relevant. Within the context of identifying the driving factors of the market's reaction to green bond announcements, many variables that have been found relevant for bonds in general are expected to be found relevant to green bonds. This literature is discussed below.

The signalling model plays a large role within the context of this research. It is predicated on the firm premise that corporate executives are more knowledgeable about their businesses than creditors or investors, implying that they are better able to predict the future cash flows of the organisation (Chin & Abdullah, 2012). The model also presupposes that corporate financing decisions are largely intended to convey managers' optimism for the future of the organisation.

With respect to debt specifically, increasing leverage has been proposed as a potentially efficient signalling tool, since it binds the corporation to a defined schedule of cash payments over the maturity period, which often serves as a credible signal of higher expected future cashflows enabling the company to pay off additional debts (Chin & Abdullah, 2012).

Through investigating the effect of global bond issuance announcements, along with company characteristics that could influence this effect, Chin and Abdullah (2012) found results revealing positive CAAR's (Cumulative Average Abnormal Returns)³, indicating that the market considers bond offers to be favourable news. Despite this finding, the cross-sectional regression analysis showed an insignificant relation of company profitability, growth opportunities, asset tangibility, size and managerial ownership with CAR's, as illustrated by the exceptionally low R-squared value of 4.4% (Chin & Abdullah, 2012).

These results contradict that of Baulkaran (2019), who found the opposite when examining the effect of global *green* bond issuances. Chin and Abdullah (2012) go on to confirm that there is a signalling effect of bond issuance announcements, which is stated to be the sole cause of the positive effect of the CARs, that is not affected by the aforementioned company characteristics. It can be seen that this finding is not only relevant to bond issues in general, but also to green bond issues.

Sustainability bonds – bonds that enable capital-raising and investment for projects that have a positive impact for *both* environmental and social outcomes – have also been studied in a similar manner by Mocanu et al. (2021) through making use of the event study and regression methodology. Reactions to announcements of global sustainability bond issues were generally minimal and unfavourable, based on the sample as a whole, with the i) size of the bond issue, ii) whether the bond is callable or not, iii) the announcement of the issue as a single event in a day, iv) the company's Return on Assets and, finally, v) the firm's social disclosure score, all

³ Cumulative Average Abnormal Returns (CAAR) is a metric utilised in financial analysis to assess the aggregate abnormal returns of a stock or portfolio across a specified duration. Abnormal returns, in this context, represent the difference between the actual return of a stock or portfolio and the expected return determined by an appropriate benchmark or market index (Binder, 1998).

being found to be statistically significant factors influencing the reaction. Moreover, the market's reaction prior and subsequent to the publication of The Sustainability Bond Guidelines by the International Capital Market Association was also recorded to be small and negative within this study (Mocanu et al., 2021).

From the above analysis, it can be concluded that the key variables that have previously been tested can be broken down into three categories, namely, firm, country and bond specific characteristics. Firstly, bond specific variables, include (but are not limited to) the following: i) announcement type – first or subsequent; ii) the presence of a green label; iii) coupon rates, iv) bond rating, v) size of the bond issue and vi) whether the bond is callable or not. Secondly, the commonly used firm specific variables are as follows: i) firm size; ii) growth opportunities/growth of the company; iii) ESG scores; iv) profitability; v) asset tangibility and lastly, vi) managerial ownership. Finally, the country specific variables include i) geographical differences – national or international; ii) fiscal balances, and iii) inflation rates.

Certain variables within the three areas mentioned above are tested within this study to determine whether or not they have a significant influence on the magnitude of the market reaction. These variables were chosen based on the variables used in comparable climate bond studies specifically, and not based on bond studies in general. Identifying the significant variables may generate several benefits related to environmental sustainability and the SDG's themselves. While the above list seems to be relatively extensive, this research examines additional factors that offer meaningful insights to the analysis – thus, contributing to its depth – alongside exploring certain variables from the aforementioned list. It must also be noted that this area remains relatively unexplored with a very limited amount of literature forming the basis of all knowledge within this subject area.

2.4.STUDY HYPOTHESES

For the first research question, the hypotheses are as follows:

1. Event Study

1.1. Null Hypothesis, H_0 :

The announcement of the issuance of climate action bonds does not induce abnormal share price returns.

1.2. Alternative Hypothesis, H_1 :

The announcement of the issuance of climate action bonds induces abnormal share price returns.

For the second research question, several hypotheses are formulated based on prior research, as discussed below for each relevant variable.

2. *Environmental (E) Disclosure Score*

Within the context of green bonds, an environmentally inclined financial instrument, including a firm-specific environmental measure provides information around how the company interacts with the environment based on its current operations. It is likely that a higher environmental score positively affects the market's reaction. This hypothesis was found to be true within the studies conducted by Baulkaran (2019), Pederson and Thun (2019) and Baker et al. (2018), all of which focused on green bonds, as well as Mocanu et al (2021), which focused on sustainability bonds, of which green bonds are a subset. This leads to the following hypotheses:

2.1. Null Hypothesis, H_0 :

The company's environmental (E) disclosure score is not, or is negatively, related to abnormal share price returns.

2.2. Alternative Hypothesis, H_1 :

The company's environmental (E) disclosure score is positively correlated to abnormal share price returns.

3. *Governance (G) Disclosure Score*

Well-governed firms are more likely to mitigate the effects of greenwashing, thereby ensuring ethical green bond issuances, which in turn, would impact the market's reaction in a positive manner, due to a reduction in the level of risk that investors take on. Further, a favourable governance score could likely induce a greenium. Both Karpf and Mandel (2017) and Bachelet et al. (2019) considered this variable within the context of both greenwashing and greeniums and found the alternative hypothesis below to be true.

3.1. Null Hypothesis, H_0 :

The company's governance (G) disclosure score is not, or is negatively, correlated to abnormal share price returns.

3.2. Alternative Hypothesis, H_1 :

The company's governance (G) disclosure score is positively correlated to abnormal share price returns.

4. *ESG Disclosure Score*

The theory supporting the hypothesis of the previous two variables, the Environmental and Governance Disclosure Scores, would apply to the ESG Disclosure Score, which is a combination of these variables as well as an additional Social Disclosure Score. Thus, the below hypotheses are proposed.

4.1. Null Hypothesis, H_0 :

The company's ESG disclosure score is not, or is negatively, correlated to abnormal share price returns.

4.2. Alternative Hypothesis, H_1 :

The company's ESG disclosure score is positively correlated to abnormal share price returns.

5. *Profitability*

It is hypothesised that more profitable firms are in better positions than that of their less profitable counterparts to issue green bonds. This is due to these firms taking on a lower level of risk, thus, making it likely that future benefits will be induced, which thereby causes a better market reaction. This hypothesis was found to be true within the studies conducted by Baulkaran (2019) and Pederson and Thun (2019), where profitability was a factor that contributed positively to the market's reaction. Thus, the following hypotheses are presented:

5.1. Null Hypothesis, H_0 :

The profitability of the company is not, or is negatively, correlated to abnormal share price returns.

5.2. Alternative Hypothesis, H_1 :

The profitability of the company is positively correlated to abnormal share price returns.

6. Size of the Issuer

Similar to the argument for the profitability variable, it has been hypothesised that larger companies that issue green bonds induce a better reaction from the market than smaller ones due to the associated perception of a lower level of risk. This variable was found significant in the study conducted by Baulkaran (2019), with results that indicated the market favouring relatively large firms that issue green bonds due to them being more reliable candidates for success. As a result, the following hypotheses are presented:

6.1. Null Hypothesis, H_0 :

The size of the issuer is not, or is negatively, correlated to abnormal share price returns.

6.2. Alternative Hypothesis, H_1 :

The size of the issuer is positively correlated to abnormal share price returns.

7. Environmental Performance Index (EPI)

EPI is considered to be an indirect measure of country specific culture regarding environmental issues and the associated affinity towards them. It assists in determining whether investors in a certain country value environmental issues more than investors in other countries. Both Wang et al. (2020) and Pederson and Thun (2019) found that different areas of the world react differently to green bond issuances, as specifically observed within the Chinese and Northern European green bond markets. As a result, the inclusion of EPI as a country specific variable aims to capture the differences in the market's reaction across different geographical locations. Thus, the hypotheses are stated as follows:

7.1. Null Hypothesis, H_0 :

The EPI of the country is not, or is negatively, correlated to abnormal share price returns.

7.2. Alternative Hypothesis, H_1 :

The EPI of the country is positively correlated to abnormal share price returns.

8. First Time vs. Subsequent Green Bond Issuances

When a company issues a green bond for the first time, the market will likely act in a cautious manner due to the lack of reputation or familiarity with these instruments. However, the same cannot be said for subsequent issuances, as these will likely have higher informational content than that of the first issue. This variable was found significant within the study conducted by Pederson and Thun (2019) and is thus included in this analysis. Thus, the hypotheses are as follows:

8.1. Null Hypothesis, H_0 :

The subsequent issuance of green bonds does not induce a more positive reaction with regards to abnormal share price returns.

8.2. Alternative Hypothesis, H_1 :

The subsequent issuance of green bonds induces a more positive reaction with regards to the abnormal share price returns.

9. *Time Dummy*

The green bond market is a recent financial innovation that has only gained momentum within the past few years. As a result, it is expected that the market would react in a more positive manner within recent years due to the new-found popularity, awareness and understanding of the instrument as opposed to before, when it was relatively new and unknown. The time period has been split into a) the years up to 2018 and b) the years after 2018. This particular time split is chosen due to the fact that subsequent to 2018, the green bond market started to gain rapid momentum and popularity. This statement is further supported by the sample used for this study which shows, in Section 3.1.2., that 86.59% of green bonds were announced subsequent to 2018. As a result, the following hypotheses are proposed:

9.1. Null Hypothesis, H_0 :

The issuance of green bonds subsequent to 2018 does not induce a more positive reaction with regards to abnormal share price returns.

9.2. Alternative Hypothesis, H_1 :

The issuance of green bonds subsequent to 2018 induces a more positive reaction with regards abnormal share price returns.

In this chapter the literature associated with the topic of this study was examined, and hypotheses developed to serve as a framework for the investigation. Chapter 3 goes on to discuss the sample, data and methodology used to conduct this research.

CHAPTER 3: SAMPLE, DATA AND METHODOLOGY

3.1.SAMPLE & DATA

This chapter discusses the sample data and methodology used in this research. This study is designed on two levels: (1) an event study which examines the market reaction to the announcement of green bonds for multiple event windows and (2) a linear regression which investigates the bond, firm and country specific factors correlated to the magnitude of this market reaction for selected windows. To test the hypotheses outlined in Chapter 2, a final sample of 276 corporate climate action bond issue announcements was compiled starting from the green bond market's inception in 2007 to 2022, with data on bond, firm and country specific attributes, as well as the historical returns of the issuing firm.

3.2.CORPORATE GREEN BOND SAMPLE

The sample of corporate green bonds was collated using the Bloomberg database, as it possesses filters to identify bonds that are aligned with each of the UN's Sustainable Development Goals. The fixed income search feature on Bloomberg was used to acquire this sample, with the "corporates" asset class filter being applied to limit the results to include only corporate bonds. Further, to identify bonds marked as "Green Bonds" through their usage of proceeds, additional filters were employed. The "Green Bonds" filter includes bonds with the associated label based on whether an issuer self-identifies as "green" or makes additional remarks about their aim to direct funding toward projects that improve the environment.

The second primary filter applied was the "Sustainable Development Goal" filter, where "13. Climate Action" was specifically chosen for the purpose of this research. This filter identifies bonds whose use of proceeds are being used specifically for this SDG. After applying these restrictions, a sample size of 358 corporate climate action bond announcements across the world were obtained. It must be noted that for this analysis the sample size is relatively small as all included bonds were required to be issued by publicly listed companies that had an equity ticker with an associated Bloomberg ESG disclosure score. Further, these bonds were not looked at within a specific time period, but instead, throughout time.

A breakdown of the filtering process can be seen in Table 1 on the next page.

Table 1: Sample Filtering Process

<i>Filter</i>	<i>Number of Bonds</i>
Corporate Bonds	2,298,860
Green Instrument Indicator	5,509
Sustainable Development Goals: (13) Climate Action	1,767
ESG Disclosure Score	519
Equity Ticker with ESG Coverage	358

Through the data cleaning process, duplicate bonds were removed, i.e., different bonds from the same company that were issued on the same day, along with those that were announced within 80 days of the date that this research was conducted, such that there was insufficient data to provide an 80-day beta estimate. Finally, bonds that possessed no share price data for days where the corresponding index had a value were also removed. This led to a final sample size of 276 corporate climate action bond announcements across the world.

3.3.SAMPLE DESCRIPTION

It is worth highlighting some aspects of the sample as presented in Table 2. In total, the issuing companies included in the sample were spread across 35 different countries, with over half (54.29%) being based in Europe. Further, 60.51% of issues in the sample are associated with countries that possess EPI scores in the top quartile. As green bonds are a relatively newly developed financial instrument, it is not surprising that 77.14% of the issues in the sample were associated with companies based in developed countries.

With regards to ESG disclosure scores, only 1.09% of the companies included in the sample possess ESG disclosure scores within the top quartile, with the rest ranking in the middle 50%. This number is relatively low and highlights the importance of improving and implementing initiatives that will increase these scores. The proportion of bonds that were announced after 2018 (86.59%) is much larger than those announced in, or before, 2018 (13.41%), which is in line with expectations given that the green bond market is young and rapidly growing. Additionally, the proportion of first time versus subsequent green bond issuances in the sample is exactly equal, implying that companies are starting to conduct more follow-on issues as the green bond market grows and matures.

Table 2: Spread of the Sample

CONTINENT SPREAD		
<i>Continent</i>	<i>N</i>	<i>%</i>
Europe	19	54.29
North America	4	11.76
South America	2	5.88
Asia	8	23.53
Africa	2	5.88
Total	35	100

DEVELOPED <i>VS.</i> DEVELOPING COUNTRIES		
<i>Economic Level</i>	<i>N</i>	<i>%</i>
Developed	27	77.14
Developing	8	23.53
Total	35	100

ENVIRONMENTAL PERFORMANCE INDEX		
<i>Rank</i>	<i>N</i>	<i>%</i>
Top 25%	167	60.51
Middle 50%	109	39.49
Lower 25%	0	0
Total	276	100

ESG DISCLOSURE SCORE		
<i>Rank</i>	<i>N</i>	<i>%</i>
Top 25%	3	1.09
Middle 50%	273	98.91
Lower 25%	0	0
Total	276	100

FIRST <i>VS.</i> SUBSEQUENT ISSUES		
<i>Number of Issuance</i>	<i>N</i>	<i>%</i>
First	138	50
Subsequent	138	50
Total	276	100

SPREAD ACROSS TIME

<i>Time Period</i>	<i>N</i>	<i>%</i>
After 2018	239	86.59
Before or in 2018	37	13.41
Total	276	100

3.4.FIRM SPECIFIC DATA

The equity ticker with ESG coverage was used to link the sample of green bonds to the appropriate share returns data on the Bloomberg Terminal. The historical equity returns for each company from the sample for a period around the announcement date was obtained, as well as the corresponding returns of the market index for the stock market on which the company was listed. This data, which was the data used to perform the event study, was taken for a time period of 90 days prior to the green bond announcement date up until 10 days after the announcement date.

3.5.EVENT STUDY

3.6.THEORY BEHIND THE EVENT STUDY METHODOLOGY

In order to investigate the market's reaction to the issuance of corporate climate action bonds, an event study may be conducted. This specific methodology was designed to investigate the effect of an event on a specific dependent variable, with the most commonly used one being the stock price of a company (Woon, 2004). An event study is defined as "a study of changes in stock prices beyond expectations, the abnormal returns, over a period of time, the event window" (Woon, 2004). In this case, abnormal returns can be attributed to the effect of the event and researchers can infer the event's significance.

Event studies commence with a hypothesis in terms of how a particular event will affect the value of a firm, which can be observed through examining the company's stock price and whether it displays abnormal returns or not (Serra, 2004). When attempting to measure the impact of a particular event, the simultaneous observation of a mixture of market wide factors, as well as other firm events must be controlled for in order to obtain accurate results (Serra, 2004). Consequently, the selection of the model to measure normal returns which serves to be the benchmark in the calculation of abnormal returns, is critical when conducting an event study.

The majority of studies use either the statistical model (constant-mean-return model or market model) or the economic model (Capital Asset Pricing Model [CAPM] or Arbitrage Pricing Theory [APT]) to measure the normal rate of return, conditional on certain variables, in order to generate abnormal return estimates for the event study methodology (Maitra & Dey, 2012).

The market model approach is simple and relatively easy to use, with pre-event data being used to estimate the parameters. Thereafter, both the stock and market index returns from the event period are used to estimate abnormal returns (Binder, 1998). This particular approach considers the stock's risk, market factor beta, and market movement during the event time (Binder, 1998). However, this model has been found to have inherent flaws. According to Hays and Upton (1986), it is susceptible to the non-stationarity of the Ordinary Least Squares (OLS) parameter estimates, which is confirmed when an event study is used. Further, Pettengill and Clark (2001) found the abnormal return estimator to be exceptionally biased. This abnormal return estimator, which estimates the return from the asset that is not related to the market return, is the key difference between the market model and the CAPM.

The CAPM model, on the other hand, marks the birth of asset pricing theory, providing insightful and compelling forecasts on how to gauge risk and the relationship between projected return and risk (Fama & French, 2004). Through being an economic model, it has the benefit of offering statistical suppositions and the potential to determine more exact measurements of normal returns using economic constraints. However, the empirical record of the model was found to be poor, which may be an indication of theoretical shortcomings brought on by numerous simplifying assumptions.

While both models have their respective advantages and drawbacks, the suitability of the model is dependent on the use for which it is intended. As a result, certain studies within the event study realm have empirically shown that the CAPM model produces comparatively superior outcomes when reporting the abnormal return of stocks when compared to that of the market model (Maitra & Dey, 2012), while others have found the market model to be the more preferable and precise choice (Binder, 1998). The market model is the most widely used model within this particular field and upon analysing several other environmental event studies specifically, it has consistently been chosen among them all. As a result, it is used as the model for the calculation of abnormal returns within this study.

3.7.EVENT STUDY METHODOLOGY

To identify the short- and medium- term effects of the announcement of green bond issues, the event study methodology is applied. Based on the abnormal share returns a company experienced around the event date, this methodology examines the market's reaction to a certain event. For this study, the event under consideration is the announcement date for the issuance of a green bond – in other words, the day that the market first receives this information. As a result, the event day (day 0) that is used in this study is the announcement date, despite the market potentially possessing information prior to this date, leading to a staggered response to the announcement.

The event windows of $[-10;10]$, $[-5;5]$, $[-3;3]$, $[-1;1]$, $[0;1]$, $[0]$ and $[0;10]$ are adopted for this study. These particular windows are a combination of the event windows used by different authors in the literature discussed in Chapter 2 above. Additionally, in order to investigate the equity market's response inside these event windows, the daily cumulative abnormal returns (CARs) are computed as the sum of the daily abnormal returns, which are defined as the discrepancy between actual returns and projected returns on a specific day.

The abnormal return for each event, which is computed using the market model, is the primary input used to evaluate the markets' response to bond announcements, in accordance with similar green bond studies within the event study realm as discussed above. Through adopting the most widely used model within this field, the obtained results can be compared to that of previous studies, thereby contributing valuably to the existing body of knowledge.

The event study methodology can be summarised into the following five steps.

Firstly, the market model parameters, alpha (α) and beta (β), for each firm-date pair are calculated using Ordinary Least Square Regression. These parameters are determined using the stock return of each company and the corresponding market return of the leading stock market index of the country it is listed in. For example, Assicurazioni Generali SpA is a company based in Italy and thus, the Borsa Italiana is used to calculate the market return in order to robustly estimate the alpha (α) and beta (β) for that specific company. To ensure that event-related information does not affect the final predicted parameters, the model is then run within an estimation window between 90 days before and 10 days after the announcement date.

Equation 1, the market model equation that was estimated, shows that the calculation of both alpha (α) and beta (β) enables the expected return on the stock of i on day t to be determined.

$$E(R_{i,t}) = \alpha + \beta_i (R_{M,t}) + \varepsilon \quad (1)$$

The primary stock market index of the country in which the company is listed, RM,t , represents the country-specific daily market return. The price data collected from Bloomberg for the firm and market indices was transformed into returns data to calculate the CAR's. This was done by firstly, dividing the price of the index on day t by the price of the index on day $t-1$, and then subsequently, subtracting 1 from that figure.

Secondly, the abnormal return is computed by deducting the expected return from the actual (observed) return.

$$AR_{i,t} = R_{i,t} - E[R_{i,t}] \quad (2)$$

It must be noted that upon plotting said AR's by day, Colbun SA, a company that had announced the issuance of a green bond on the 14th of October 2021, exhibited a 4 standard deviation move, four days prior to the green bond announcement. Despite carefully examining news events on this day, as well as the day before and after, with regards to the company and industry, no event was able to explain this move and thus, it was classed an outlier worth removing in order to minimise the disproportionate effect on the statistical results of this analysis. It must be noted that this was the only outlier that was identified and removed.

Thereafter, the CAR's for each firm is computed by summing the abnormal returns for each issuing firm within the event window. The dependent variable was calculated for multiple event windows, both short- and medium-term, in order to robustly estimate the market's reaction to the announcement of a green bond issuance from the perspectives considered by the literature in Section 2.2.

$$CAR_{i,t} = \sum AR_{i,t} \quad (3)$$

The average CAR across the sample of enterprises is then calculated to yield the CAAR of the sample.

$$CAAR(T_1; T_2) = CAR(T_1; T_2)/N \quad (4)$$

Where:

- T_1 is the start of the event window under consideration
- T_2 is the end of the event window under consideration

Finally, using Equation 4, the significance of the abnormal returns is tested through using the cross-sectional t-test, which is chosen due to this event study being categorised as a cross-sectional study, since the CAAR's are shown for companies across certain time frames for the CAAR of each chosen event window.

The following T statistics are then created to test the null hypothesis that the announcement of a green bond does not cause abnormal stock returns during the designated event windows.

$$H_0 : CAAR(T_1;T_2) = 0$$

$$H_1 : CAAR(T_1;T_2) \neq 0$$

These t values are then evaluated for significance by comparing them to the critical values of a two-sided t-test with confidence intervals of 90%, 95%, and 99%. As such, the t-statistics are calculated as indicated below.

$$T_{Cross} = CAAR(T_1;T_2) / \hat{\sigma} CAAR(T_1;T_2) \quad (5)$$

The standard deviation of the sample is included in the equation for the t-statistic which is determined as below.

$$\hat{\sigma}_{Cross} = [1/N(N-d)] \sum_{i=1}^N (CAR_i(T_1;T_2) - CAAR(T_1;T_2))^2 \quad (6)$$

Where:

- d represents the common difference of an arithmetic sequence

Through implementing this process, the CAAR's of each of the event windows stated above were calculated. An analysis of the results can be seen.

3.8. REGRESSION METHODOLOGY

Subsequent to carrying out the event study, a regression analysis is conducted. This model goes hand in hand with the event study methodology and assists in understanding which variables are significant for the description of the dependent variable, as well as the impact that these variables have on the CAR value.

3.9. REGRESSION VARIABLES

In addition to the data obtained for the event study, further data was collected on other variables that may be significant in describing the dependent variable in order to perform the regression analysis. Within this sample, the data collated included the Return on Equity (profitability) of the issuing firm, the environmental disclosure score (E), the governance disclosure score (G), and the ESG disclosure score. The reason for including the governance score was to determine whether the company could be trusted to spend the green bond proceeds in a suitable manner, i.e. it is considered as a proxy for the trustworthiness of the firm. This variable was not used in the normal ESG disclosure score context, thereby explaining why the final component of the score, the social disclosure score (S), was not assessed in isolation.

The market capitalisation (size) of the issuer, which was transformed to the natural log form to obtain a distribution that is more normal, was used as a proxy for the size of the firm. This measure was used instead of total assets, as in Baulkaran (2019) and Pedersen and Thun (2019), as it was used by the majority of the other climate studies examined. Data for the first versus subsequent announcements, where subsequent (non-initial) issues were coded a 1 and 0 otherwise, was also included in the sample. It must be noted that very few firms issued bonds within 3 months of a prior issue and thus, changes to the results of the study due to event overlaps would have been negligible.

The Environmental Performance Index (EPI) score was obtained manually from the Socioeconomic Data and Applications Centre due to Bloomberg not having a filter for it. Further, a time dummy variable was also included, allowing for the total time period to be split into announcements during or before 2018, coded as 0, and after 2018, coded as 1. In the context of this study these variables were considered as possible determinants of the general market behaviour of the company. They were not intended to be considered as information that was readily available for investors to use as part of an investment strategy when the bond was announced and thus, any informational timing delays do not impact the results of the study. A summary of the dependent variables used in this part of the study can be seen in Table 3 below.

Table 3: Regression Variables

<i>Variable</i>	<i>Nature</i>	<i>Data Source</i>
First Time vs Subsequent Time Issuance	Bond-specific	Bloomberg
Time Dummy Variable	Bond-specific	Bloomberg
Size of the Issuer	Bond-specific	Bloomberg
Environmental Score (E)	Firm-specific	Bloomberg
Governance Score (G)	Firm-specific	Bloomberg
ESG Disclosure Score	Firm-specific	Bloomberg
Profitability of the Issuing Firm	Firm-specific	Bloomberg
EPI Score	Country-specific	Socioeconomic Data and Applications Centre

3.10. THE MULTIPLE LINEAR REGRESSION MODEL

For the purpose of this analysis, the multiple linear regression methodology is used to determine variables that are significant for the description of the dependent variable, as well as the impact these variables have on the CAR value.

The dependent variable was split into two, the 11-day CAR per company and the 1-day CAR per company, in order to obtain both a 1-day short- and an 11-day medium-term perspective with regards to the market's reaction to the announcement of a green bond issuance. This was done because the immediate market reaction likely encompassed a lot of the hype associated with these instruments, which the 1-day CARs would display, and thus, the 11-day CARs were included to determine whether this reaction persisted over a longer period of time. As a result, of the four statistically significant CAR windows, these two were chosen specifically. Further, because the correlation between the ESG Disclosure Score and both the Environmental Disclosure Score (E) and the Governance Disclosure Score (G) was relatively large as anticipated, with values of 0.840 and 0.702 respectively as seen in Table 4 , two separate regressions were run for each of the event window periods (1- and 10 days) in order to measure their contributions accurately - i.e., one regression per post-event window period that included the ESG Disclosure Score but not the Environmental (E) and Governance Scores (G), and another that included the latter two, but not the former. Further, separate models were run to test the time dummy variable, utilising the regression excluding the Environmental Disclosure

Score (E) and the Governance Disclosure Score (G). Both the 1-day and the 11-day CAR per Company values for each of these three distinct regressions were tested as dependent variables, thereby eventually yielding a total of six different regressions as follows.

The multiple linear regression formula is given by the following equations:

$$y_{1\text{-day}} = \beta_0 + \beta_1\text{ESG} + \beta_2\text{IssuerSize} + \beta_3\text{Profitability} + \beta_4\text{FvS} + \beta_5\text{EPI} + \varepsilon_i \quad (7)$$

$$y_{11\text{-day}} = \beta_0 + \beta_1\text{ESG} + \beta_2\text{IssuerSize} + \beta_3\text{Profitability} + \beta_4\text{FvS} + \beta_5\text{EPI} + \varepsilon_i \quad (8)$$

$$y_{1\text{-day}} = \beta_0 + \beta_1\text{E} + \beta_2\text{G} + \beta_3\text{IssuerSize} + \beta_4\text{Profitability} + \beta_5\text{FvS} + \beta_6\text{EPI} + \varepsilon_i \quad (9)$$

$$y_{11\text{-day}} = \beta_0 + \beta_1\text{E} + \beta_2\text{G} + \beta_3\text{IssuerSize} + \beta_4\text{Profitability} + \beta_5\text{FvS} + \beta_6\text{EPI} + \varepsilon_i \quad (10)$$

$$y_{1\text{-day}} = \beta_0 + \beta_1\text{ESG} + \beta_2\text{IssuerSize} + \beta_3\text{Profitability} + \beta_4\text{FvS} + \beta_5\text{EPI} + \beta_6\text{Time} + \varepsilon_i \quad (11)$$

$$y_{11\text{-day}} = \beta_0 + \beta_1\text{ESG} + \beta_2\text{IssuerSize} + \beta_3\text{Profitability} + \beta_4\text{FvS} + \beta_5\text{EPI} + \beta_6\text{Time} + \varepsilon_i \quad (12)$$

Where:

- $y_{1\text{-day}}$ represents the 1-day CAR per company
- $y_{11\text{-day}}$ represents the 11-day CAR per company
- ESG represents the ESG disclosure score
- IssuerSize represents the log of the market capitalisation in USD which was used as a proxy for the size of the issuer
- Profitability represents the return on equity which was used as a proxy for the profitability of the issuer
- FvS represents whether the bond was a first- or subsequent-time issuance
- EPI represents the EPI of the country where the issuing company is based
- E represents the environmental disclosure score
- G represents the governance disclosure score
- Time represents the time dummy variable
- ε represents the variance not explained by the model

By minimising the sum of the squares of the vertical deviations between each data point and the line, the least-squares model determines the line that best fits the observed data. The values that the multiple linear regression equation fits are designated ($\hat{y}_i$), while the residuals (ε_i) represent the differences between the values that are observed and those that are fitted. The sum of the residuals is given by the equation below and is equal to zero.

$$RSS = \sum (y_i - \hat{y}_i)^2 \quad (13)$$

The variance σ^2 , which is also known as the mean-squared error, is estimated via the following formula, where the estimate of the standard error (s) is equal to the square root of the variance.

$$\sigma^2 = \sum e_i^2 / n - p - 1 \quad (14)$$

Where:

- n represents the sample size
- p represents the number of parameters in the model

After the regression coefficients that lead to the smallest overall model error have been calculated, the significance of the parameters must be tested. For any of the variables X_n included in a multiple regression model, the null and alternative hypotheses are stated as follows.

$$H_0 : \beta_j = 0$$

$$H_1 : \beta_j \neq 0$$

Thereafter, a test statistic is established to test both the null and alternative hypothesis as follows.

$$T_{\text{stat}} = \beta_j / s_{\beta_j} \quad (15)$$

Finally, a confidence interval for the parameter β_j is set taking the form below, where t^* is equal to the appropriate critical value from the t distribution.

$$\beta_j \pm t^* s_{\beta_j} \quad (16)$$

From this analysis, variables that have a statistically significant correlation with the dependent variable – the market reaction – can be identified, thus completing the analysis.

3.11. OLS ASSUMPTIONS

The data generation process for these models are fully described by a set of five assumptions discussed below. All of these assumptions were tested for each of the six regressions to ensure accurate estimators.

Firstly, linearity. This assumption states that there must be a linear relationship between the dependent and independent variables. A simple scatterplot between these variables provides visual representations to determine whether there are any problems such as any relationships, other than linear, being present. The scatterplot equation indicates whether the relationship is linear through examining the slope term. The equations for all variables for each of the six regressions is shown in Appendix A.1, indicating that none possess non-linear relationships.

Secondly, independence. If the regression model's error terms are uncorrelated, then this assumption is met (Burton, 2021). The Durbin-Watson statistic, which ranges from zero to four, can be used to test this assumption statistically. A Durbin-Watson test statistic of two denotes a weak correlation between residuals, exposing independent error components in the model. A general rule followed is that Durbin-Watson test statistic values within the range 1.5 – 2.5 are relatively acceptable. This statistic for each of the six regressions can be seen in Appendix A.2, indicating that all values are close to 2, and none exceed the bounds of the general rule.

Thirdly, normality. This assumption states that the error term must be normally distributed around the multiple regression plane (Burton, 2021). The most effective way to evaluate this visually is through quantile comparison plots and kernel-density estimates that test for normality by placing studentised residuals onto a line that depicts the normal distribution quantile (quantile comparison plot) and a normal curve (kernel-density plot). The graphical representation of the residuals is presented in Appendix A.3, indicating that they do not follow a perfect normal distribution. However, the violation of this assumption is often not a problem, due to the Central Limit Theorem which states that even when the data is not normally distributed, the sample means of fairly large samples are frequently well-approximated by a normal distribution.

Fourthly, constant error variance. This assumption states that the error variance around the regression plane is constant (Burton, 2021). A scatterplot with studentised residuals displayed against the unstandardized projected values can be used to test this or it can be statistically tested through the Breusch-Pagan test. The Breusch-Pagan test results can be seen in Appendix A.4, which indicates that none of the p values are less than 0.05 and thus, the null hypothesis

is not rejected and there is insufficient evidence to state that heteroskedasticity is present within the model.

Finally, the absence of multicollinearity, which occurs in an OLS multiple regression model when two or more independent variables have a linear relationship that is almost perfect (Burton, 2021). The two basic methods used to test for multicollinearity is by examination of the bivariate correlations between each pair of independent variables, and assessing the variance inflation factors (VIF) of each predictor in the model. The VIF factors for each of the six regressions can be found in Appendix A.5, indicating that values close to 1 are obtained for all variables. This indicates that there is no correlation between a given explanatory variable and any other explanatory variables in the model, as desired.

Adding to the discussion of multicollinearity, Table 4 below shows the correlation matrix of the variables included in the regression analysis. As previously mentioned, the correlation between the ESG Disclosure Score and both the Environmental Disclosure Score (E) and the Governance Disclosure Score (G) was relatively large as anticipated, with values of 0.840 and 0.702 respectively. This was accounted for through conducting two different regressions in order to measure these variables' contributions accurately as explained above. The table further shows that the correlations between all other variables are below the critical limit.

Based on the results of the aforementioned diagnostic tests, it can be seen that the OLS assumptions were met and thus, it can be said that the estimators in each of the six regressions are accurate.

Table 4: Correlation Matrix

	<i>Size of the Issuer</i>	<i>Profitability</i>	<i>First vs Subsequent</i>	<i>EPI</i>	<i>ESG Disclosure Score</i>	<i>Time (≤2018)</i>	<i>Governance Score</i>	<i>Environmental Score</i>	<i>CAAR Per Company (Y) 11 Day</i>	<i>CAAR Per Company (Y) 1 Day</i>
<i>Size of the Issuer</i>	1									
<i>Profitability</i>	0.01026	1								
<i>First vs Subsequent</i>	0.0825	-0.0290	1							
<i>EPI</i>	-0.3259	-0.1118	0.0727	1						
<i>ESG Disclosure Score</i>	0.0047	0.1713	-0.0035	0.0073	1					
<i>Time (≤2018)</i>	0.0440	0.0771	-0.0744	-0.2492	-0.0639	1				
<i>Governance Score</i>	0.0709	0.0899	-0.0881	0.01368	0.7021	0.0159	1			
<i>Environmental Score</i>	-0.0040	0.1329	0.1021	0.1034	0.8480	-0.1601	0.3561	1		
<i>CAAR Per Company (Y) 11 Day</i>	-0.0148	0.1701	-0.1031	0.0422	-0.0210	0.0013	-0.0258	-0.0034	1	
<i>CAAR Per Company (Y) 1 Day</i>	-0.1026	-0.0163	-0.0497	0.0228	-0.0428	0.0415	-0.0645	-0.0426	0.395018035	1

CHAPTER 4: RESULTS & ANALYSIS

This chapter discusses the results of both the event study and regression analyses, subsequent to analysing the descriptive statistics.

4.1.DESRIPTIVE STATISTICS

An examination of several descriptive statistics was conducted in order to acquire some initial insight into the dataset. This provided information about the fundamental nature and features of the study data prior to the methodology being applied.

The analysis was carried out for the 276 corporate climate action bond announcements from the green bond market's inception in 2007 up until 2022. Table 5 shows the descriptive statistics of the original data consisting of the maximum, minimum, mean, median and standard deviation for each bond, firm and country specific measure.

Table 5: Descriptive Statistics

<i>Variable</i>	<i>N</i>	<i>Max</i>	<i>Min</i>	<i>Mean</i>	<i>Median</i>	<i>Standard Deviation</i>
BOND-SPECIFIC CHARACTERISTICS						
First Time vs. Subsequent Time Issuance	276	1	0	0.50	0.50	0.50
Time Variable	276	1	0	0.87	1.00	0.34
FIRM-SPECIFIC CHARACTERISTICS						
Size of the Issuer (USD mn)	276	17.89	6.16	10.50	10.35	1.97
ESG Disclosure Score	276	82.46	22.39	52.30	51.49	9.76
Environmental Score (E)	276	83.81	0	40.11	39.57	14.48
Governance Score (G)	276	99.31	50.84	82.21	83.96	10.33
Profitability of the Issuing Firm (ROE%)	276	217.72	-91.12	11.66	9.25	20.93
COUNTRY-SPECIFIC CHARACTERISTICS						
EPI	276	93.10	27.60	72.76	77.80	13.34

It is worth highlighting some aspects of the data as presented above. Firstly, in terms of bond-specific characteristics, it should be noted that both the first versus subsequent time issuance

and time variables are reported as dummy variables. From this, it can be seen that the ratio of first versus subsequent time issuances is split equally, with a mean of 0.5, suggesting that the exponential growth of this market is equally due to both new and subsequent green bond issuers adopting and furthering this financial innovation. Contrastingly, the time variable's mean is reported to be a lot higher, possessing a value of 0.87, thus indicating that many more green bond issuances took place after 2018, as expected.

The average overall Bloomberg ESG disclosure score for the companies in the study is reported to be 52.30, with a minimum score of 22.39 and a maximum score of 82.46. The relatively high standard deviation of 9.76% for this variable suggests that there is significant variance in the reported ESG score among the different companies in the study.

Through including two of the ESG disclosure score sub-components, further insight can be gained into the overall score. The environmental score has a larger variance, 14.48%, and lower mean, 40.11, when compared to the governance score, which is likely a result of environmental considerations being a relatively recent investor and business focus compared to governance. Thus, the governance disclosure variable displays much higher mean and minimum values of 82.21 and 50.84 respectively. The variance of the overall ESG disclosure score is lower than that of the variance of both the environmental and governance scores, suggesting that the variance of the social score is much lower than its E and G counterparts.

The profitability of the issuing firm possesses the largest variance of 20.93%, which is expected due to fact that firms can hold negative profitability values, thus, increasing the range of figures that the variable can take. This is further supported by the fact that a diverse range of firms and industries were included in the sample, whose profitability figures would have varied drastically.

Finally, in terms of country-specific characteristics the variance of the EPI variable is relatively high, with a value of 13.34%, however, this can be considered normal due to the fact that this is a ranked variable across 180 countries, all of which performed differently across the 40 different performance measures that the variable is based upon. Further, due to the fact that there are so many countries included, a large range is expected, especially with the stark differences between more and less economically developed countries.

4.2. EVENT STUDY

The results of the calculations made for the estimation windows described in Section 3.4. are presented in Table 6, which is followed by an in-depth discussion of the significant event windows.

Table 6: CAARs (Market Model)

Event Time	CAAR	T Statistic
[0]	0.0013	2.4304**
[-1,0]	0.0014	1.3265
[0, 1]	7.56E-06	0.0071
[-1, 1]	0.0004	0.2272
[-3, 3]	0.0156	4.1782***
[-5, 5]	0.0242	4.1304***
[-10, 10]	-0.0082	-0.7338
[0,10]	-0.0259	-4.4239***

***Significance for a 2-tailed test at the 1% level.

**Significance for a 2-tailed test at the 5% level.

*Significance for a 2-tailed test at the 10% level.

From Table 6, it can be seen that the CAARs are statistically significant for four out of the eight periods examined, with the largest and most significant return being observed over the [0,10] period. This window was found to be statistically significant at the 1% level, with a *negative* value of -0.0259, implying that the that market returns fell by -2.59% over the 11-day window commencing on day 0. These results directly contradict the results of the study carried out by Tang and Zhang (2020), which examined the global green bond market from 2007 to 2017 and found a *positively* and statistically significant CAARs of 1.39% around the green bond announcement. Despite these contradicting results, it must be noted that the green bond market is growing at an exponential rate and thus, it is highly likely that different results will be obtained subsequent to including data from 2017 onwards, as the market only started to gain momentum in recent years.

The [0] window appears to be statistically significant at the 5% level, with a *positive* value of 0.0013. This implies that market returns rise by 0.13% on the day of the event itself. From this, it can be said that a statistically significant positive (albeit small) equity investor reaction takes

place for green bond issuance on the day of its announcement, thus, confirming hypothesis 1.2. in Section 2.4., according to which the announcement of the issuance of climate action bonds induces abnormal share price returns.

The studies conducted by Glavas (2018) and Kuchin et al. (2019) – which examined the global green bond market from 2013 to 2017 and 2007 to 2019 respectively – also observed the most significant return on the null day, with CAAR values of 0.46% and 0.52% respectively. Despite these values being higher than that of the value obtained in this study, the exponential growth of the green bond market within recent years and its ability to influence results, as explained above, should be noted.

Finally, the $[-3,3]$ and $[-5,5]$ windows appear to be statistically significant at the 1% level, with *positive* values of 0.0156 and 0.0242 respectively. Thus, market returns are 1.56% and 2.42% over the respective windows. According to Flammer (2021), except for the $[-1,0]$ window, all other intervals examined in that study ($[-20,11]$; $[-10,6]$; $[-5,2]$; $[1,5]$; $[6,10]$ and $[11,20]$), yielded CAARs that were small and statistically non-significant, thus inferring that the results were not driven by unrelated trends around the event dates. When considering the CAAR's associated with these windows ($[-3,3]$ and $[-5,5]$), along with the $[0,10]$ and $[0]$ windows) within this study, it can clearly be seen that this is not the case.

Based on the aforementioned results, in terms of market efficiency, it can be said that the market best displays characteristics consistent with weak form efficiency. This is due to the fact that the largest and most significant return was observed over the $(0;10)$ period, thereby meaning that the market did not react immediately to the new information, as abnormal returns persisted for a while after the announcement. However, it can be said that based on similar statistically significant returns of the $(-3;3)$ and $(-5;5)$ windows, elements of strong form efficiency can also be seen, thereby inferring that insiders may be trading on certain information before the announcement. Despite these results also displaying characteristics of semi-strong form efficiency, through the statistically significant return for the (0) window, this result was much smaller when compared to its counterparts and thus, it can be said that all new information does not reflect within the price of the security immediately.

Despite the positive and significant results for the aforementioned periods, when examining Figure 1 below which displays the CAARs by day, it can be seen that prior to the green bond

announcement between day -10 and -4, the market is relatively flat. However, the start of a significant increase is observed, commencing on day -4, causing the CAARs to peak on the null day, after which, a general *negative* trend is observed. The increase in the CAARs from day -4 to the null day can potentially be a result of trading occurring based on insider information being leaked within the market. This poses as an interesting phenomenon as the insiders are likely expecting these instruments to be received positively through pushing the CAARs up during this period. However, once the bond announcement goes public, the market reaction is, in fact, negative, thereby highlighting a possible difference in the expectations of the insiders and the market.

Investors may perceive the announcement of a new green bond issuance, which in many cases could be interpreted as the announcement of an impending evolution of operational and capital expenditures to make a business more sustainable, as a practise that creates uncertainty with regards to the profitability of new and more sustainable business models. A consideration of this nature can result in a lower revision of risk-adjusted profitability predictions. Further, given that green bonds are still relatively new and unknown instruments, coupled with the fact that there is an ongoing debate regarding how effective they will be in addressing climate change, this view may be confirmed - i.e., investors may factor in the risk of greenwashing and its potential stock market repercussions when valuing a firm, thereby changing their investment strategy and "punishing" such actions by selling their holdings.

Thus, it can be said that the negative market reaction could either mean that equity investors do not see these instruments to be value adding with the potential to destroy profits, or that they do not have confidence that the proceeds will be used for their intended purpose. These results are consistent with the study conducted by Lebel et al. (2020), which found negative CAAR's across *all* the periods examined, thereby suggesting that the market reacts negatively to the announcement of green bond issuances and inferring that green debt offerings convey unfavourable information about the issuing firms to the market. Further, according to Tang and Zhang (2020), within the straight (non-green) bond issuance announcement literature, the stock market response to a straight bond issuance is associated with a marginally negative return in the shorter window, consistent with the results that this study has found.

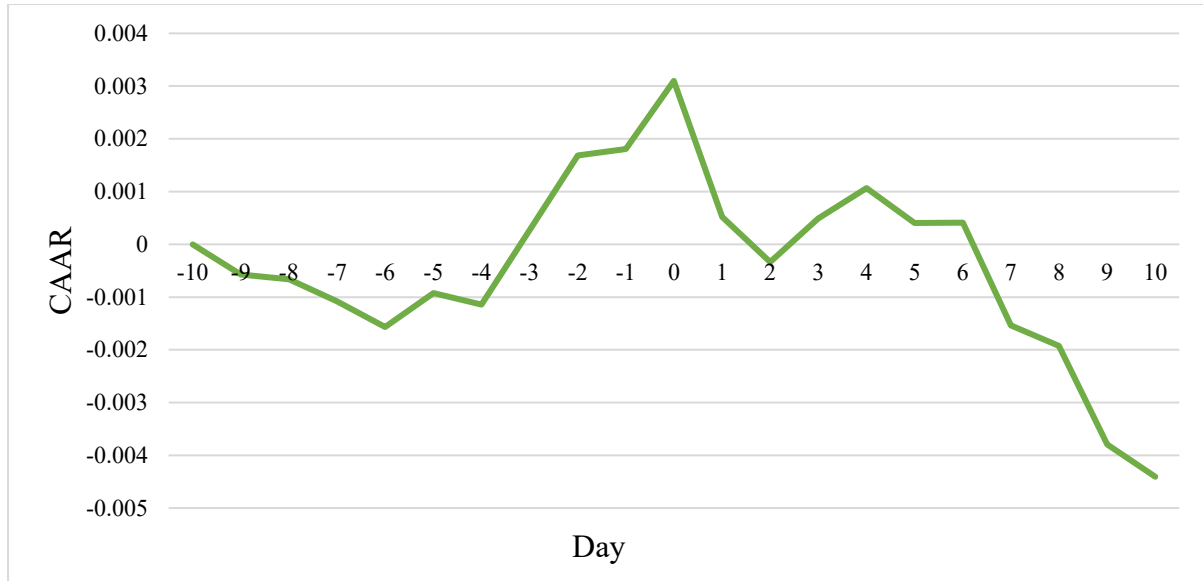


Figure 1: CAAR by Day (-10;10)

4.3. REGRESSION

The CAR's from the event windows [0], the 1-day event window, and [0;10], the 11-day event window, are used as the dependent variables in the regressions conducted below, as they are the statistically significant main variables of interest from the event study analysis. The independent control variables are the bond, firm and country-specific characteristics discussed in Chapter 3. The results from the multiple regression analysis are presented in Table 7 below.

As mentioned above, the ESG Disclosure Score variable is highly correlated with both the Environmental (E) and Governance (G) Disclosure Scores and thus, two separate sets of regressions are run to measure their respective contributions in isolation. Regressions (1) and (2) include the ESG Disclosure Score variable, while omitting the Environmental (E) and Governance (G) Disclosure Scores, whereas the opposite is true for Regressions (3) and (4). Regressions (5) and (6) are extensions of regressions (1) and (2), with the time variant controls added.

Table 7: Regression Results

	(1) 1-Day ESG	(2) 11-day ESG	(3) 1-Day E & G	(4) 11-day E & G	(5) 1-Day Time Dummy ESG	(6) 11-day Time Dummy ESG
Variables	CAR	CAR	CAR	CAR	CAR	CAR

Size of the Issuer	-0.0010 (0.0006) (0.1157)	0.0005 (0.0019) (0.7865)	-0.0010 (0.0006) (0.1379)	0.0007 (0.0019) (0.7327)	-0.0009 (0.0006) (0.1213)	0.0005 (0.0019) (0.7895)
Profitability	9.304E-06 (0.0001) (0.8658)	0.0005** (0.0002) (0.0026)	-8.8071E-06 (0.0001) (0.8726)	0.0005** (0.0002) (0.0031)	-1.1574E-05 (0.0001) (0.8340)	0.0005** (0.0002) (0.0027)
ESG Disclosure Score	-7.75E-05 (0.0001) (0.5086)	-0.0003 (0.0004) (0.3753)	N/A	N/A	-7.1706E-05 (0.0001) (0.5424)	-0.0003 (0.0004) (0.3734)
First vs Subsequent	-0.0015 (0.0023) (0.5005)	-0.01250* (0.0071) (0.0815)	-0.0017 (0.0023) (0.4703)	-0.0130* (0.0073) (0.0740)	-0.0014 (0.0023) (0.5247)	-0.0125* (0.0072) (0.0816)
EPI	-1.14E-05 (0.0001) (0.8992)	0.0003 (0.0003) (0.2305)	-5.4723E-06 (0.0001) (0.9521)	0.0004 (0.0003) (0.2204)	3.1899E-06 (0.0001) (0.9727)	0.0003 (0.0003) (0.2545)
Environmental Score	N/A	N/A	-2.2223E-05 (0.0001) (0.7944)	-2.36E-05 (0.0003) (0.9298)	N/A	N/A
Governance Score	N/A	N/A	-9.8397E-05 (0.0001) (0.4067)	-0.0003 (0.0004) (0.4191)	N/A	N/A
Time Dummy	N/A	N/A	N/A	N/A	0.0023 (0.0034) (0.5032)	-0.0011 (0.0108) (0.9189)
Constant	0.0171 (0.0121) (0.1575)	-0.0193 (0.0380) (0.6119)	0.0211 (0.0134) (0.1164)	-0.0125 (0.0423) (0.7679)	0.0136 (0.0132) (0.3028)	-0.0176 (0.0415) (0.6715)
Observations	276	276	276	276	276	276
R-squared	0.0142	0.0463	0.0164	0.0464	0.0158	0.0464
Adjusted R-squared	-0.0041	0.0287	-0.0055	0.0252	-0.0061	0.0251
F Test	0.7769 (0.0187)	2.6228** (0.0588)	0.7486 (0.0187)	2.1836** (0.0589)	0.7210 (0.0187)	2.1794** (0.0589)

Standard Errors reported in parentheses.

P Values reported in parentheses underneath the standard errors.

***Significance for a 2-tailed test at the 1% level.

**Significance for a 2-tailed test at the 5% level.

*Significance for a 2-tailed test at the 10% level.

The discussion of the regression results will be split according to the length of the event window. First, regressions (1), (3) and (5), the 1-day event windows, will be discussed, followed by regressions (2), (4) and (6), the 11-day event windows.

4.4.1-DAY EVENT WINDOW REGRESSIONS

Firstly, the 1-day event windows, regressions (1), (3) and (5), are discussed. Five of the eight statistically non-significant variables display negative signs within the regressions, namely the variables relating to the size of the issuer and whether an announcement is with regards to the first green bond issue of a company or a subsequent one in all regression models, the ESG disclosure score in regressions (1) and (5), and the environmental and governance scores in regression (3).

The *size of the issuer* variable is found to be statistically non-significant, meaning that the market does not respond to changes in this factor. This contradicts the expectation of a significant and positive stock market reaction to larger firms announcing the issuance of a green bond, as outlined in Section 2.4. This was the expectation due to larger firms being perceived to have a lower level of risk and a higher probability of success. The figures shown in Table 7 imply decreases of 0.1%, 0.1% and 0.09% in the CAR's respectively resulting from a large firm announcing a green bond issuance. This finding is not in accordance with the study conducted by Baulkaran (2019), which suggested that the market would place higher value on large firms that issued green bonds because they would be seen as reliable candidates that would have a higher rate of success.

The *first vs. subsequent* green bond announcement variable failed to meet the expectations in terms of sign, as outlined in hypothesis 8.2. in Section 2.4., that the subsequent issuance of green bonds induces a more positive reaction with regards to the abnormal share price returns due to the variable being statistically non-significant. This contradicts the results of the study conducted by Pederson and Thun (2019), which deemed *subsequent issuances* a “fundamental channel” and a potential driver for the positive stock market reaction.

Similarly, the *environmental disclosure score*, the *governance disclosure score* and the *ESG disclosure score* variables also failed to meet the expectations outlined in their hypotheses (hypotheses 2.2., 3.2. and 4.2. in Section 2.4.) as well as the findings of studies conducted by

other authors, all of which implied that these scores should be positively correlated to abnormal share price returns.

The *time dummy* variable on the other hand, appeared to be positively correlated with the CARs, thus meeting the expectations outlined in hypothesis 9.2. in Section 2.4. However, this variable is not statistically significant, thus indicating that there is no clear evidence that the time period in which the bond was announced makes a difference to the market reaction. The results of this variable are inconsistent with the results of the sustainability bond study conducted by Mocanu et al. (2021), which found that a variable comparing the market's reaction prior and subsequent to the publication of The Sustainability Bond Guidelines by the International Capital Market Association in 2018 to be significant and negative. However, the same bond market is not used within this study, which could explain this result.

The signs of the last remaining variables (both statistically non-significant) namely the *EPI* and the *profitability* variables, vary across the three different regressions.

The result of the *EPI variable* for regressions (1); (3) and (5) appeared to be statistically non-significant and thus, failed to meet the expectations outlined in hypothesis 7.2. in Section 2.4., which suggested that the EPI of the country is positively correlated to abnormal share price returns. The positive result intuitively makes sense as the EPI score was used as a proxy for a country's culture in terms of valuing green initiatives and thus, investors in countries with high EPI scores would likely place greater value on green bonds than those in countries with lower EPI scores. It must be noted that this is the first time that this variable is being used in such a study, to the best of the author's knowledge, and thus, there is a lack of theory to support these notions.

The results of the *profitability* variable for regressions (1); (3) and (5), were again, non-significant, and thus, were not in accordance with the expectations outlined in hypothesis 5.2. in Section 2.4., in terms of the sign, as well as the findings of the only other two *green bond* studies, conducted by Baulkaran (2019) and Pederson and Thun (2019), both of which found a *positive* and *statistically significant* relationship with this variable and the CAR's.

When considering the above discussion of the variables, it must be noted that their corresponding p-values indicate that the evidence is not strong enough to suggest that these effects exist within the population, i.e., for the variables with negative signs, there is insufficient evidence to confirm that an increase in any of these three variables will result in a decrease of the CAR, as predicted by the model. The same can be said for that of the variables with positive signs. i.e., there is insufficient evidence to confirm that an increase in these variables will result in an *increase* of the CAR, as predicted by the model.

It must be noted that the F-tests show each of the three models to be non-significant, thereby indicating a weak influence of these bond, firm and country-specific characteristics on the CAR's. The R-squared values of 1.42%, 1.64% and 1.58% also imply that these variables lack the power to explain the variation in cumulative abnormal returns. Moreover, they are exceptionally low when compared to the two other main green bond studies conducted by Baulkaran (2019) and Pederson and Thun (2019), which possessed R-squared values of 33% and 22% respectively, as discussed in Chapter 2.

Following the analysis of the above 1-day event window regressions (1), (3) and (5), the 11-day event window regressions, (2), (4) and (6) are discussed below.

4.5.11-DAY EVENT WINDOW REGRESSIONS

With this set of regressions, there are two key findings. Firstly, the results show the *profitability* variable to be positively correlated with the CARs and statistically significant at the 5% level across all three models. This confirms the notion of a significant and positive stock market reaction to profitable firms announcing green bond issuances and implies increases of 0.5% in the CAR's for all three regressions. This result exactly matches that of the other two green bond studies identified, namely those conducted by Baulkaran (2019) and Pederson and Thun (2019), both of which found a positive and statistically significant relationship with this variable. Further, this finding is in line with the expectation that the profitability of the company is positively correlated to abnormal share price returns as discussed in Chapter 2. Thus, this could infer that the market finds profitable firms to be in better positions to issue these instruments as they likely possess a lower level of risk. Finally, the switch in the sign of the variable between the 1-day and the 11-day event window should be noted.

The second key finding is that the *first vs. subsequent* variable is negatively correlated with the CARs and statistically significant at the 10% level across all three models. Decreases of -1.25%, -1.3% and -1.25% in the CAR's are recorded for regressions (2), (4) and (6), respectively, resulting from the announcement of the issuance of a green bond for the first time as opposed to subsequent times. Through also possessing a negative sign, as with that of the 1-day event window results, this finding contradicts supporting literature and expectations for the reasons stated in the analysis of the 1-day event window results with regards to this variable specifically. Further, the same interpretation as that of the 1-day event window explanation for this variable can be applied.

When considering the analysis of these two variables specifically, due to their corresponding p-values being statistically significant, it can be said that the evidence is strong enough to suggest that these effects exist within the population.

The remaining six variables within these three regressions are all statistically non-significant, these being the *ESG disclosure score* for regressions (2) and (6); the *environmental* and *governance disclosure scores* for regression (4); the *time dummy* variable in regression (6); the *size of the issuer* variable and finally, the *EPI* variable. Because the results match that of the 1-day event window regression results, the same explanations regarding expectations and supporting literature apply.

When considering the above discussion of the non-significant variables, it must be noted that their corresponding p-values indicate that the evidence is not strong enough to suggest that these effects exist within the population.

Through examining the F-tests, contrary to the results of the 1-day event window regressions, the three models appear to be statistically significant at the 5% level, indicating a relatively strong influence of the bond, firm and country-specific characteristics on the CAR's. However, the R-squared values of 4.63%, 4.64% and 4.64%, despite being higher than that of the corresponding 1-day event window R squared values, still imply that these variables lack the power to explain the variation in cumulative abnormal returns. Further, they are still relatively low compared to that of the two other main green bond studies, conducted by Baulkaran (2019) and Pederson and Thun (2019), which possessed values of 33% and 22%, as previously mentioned.

4.6.COMPARISON OF 1-DAY AND 11-DAY EVENT WINDOW REGRESSIONS

When comparing the results of the 1-day and the 11-day regressions, certain key points should be noted. Firstly, there are differences in the significance of the variables within the different event windows. The 1-day regressions do not show any of the variables to be statistically significant in impacting the cumulative abnormal returns of the company, whereas the 11-day regressions show both the *profitability* and the *first vs subsequent* variables to be statistically significant. This illustrates market behaviour to an extent and shows how the market places value on different variables at different points within the event window, according to the models, subsequent to the announcement of a green bond issuance. i.e., initially, the market may be uncertain as to which characteristics it values and may need to analyse the bond announcement in greater detail, thereby explaining the lack of significance of all the variables included in this analysis within the 1-day event window, before deeming profitability and first vs subsequent issuance important characteristics subsequent to further research. Interestingly, neither set of regressions find any of the variables other than these two to be significant, which goes against the expectations outlined in Chapter 2.

This chapter discussed the results of both the event study and the regression analyses. The next chapter goes on to conclude the study.

CHAPTER 5: CONCLUSION AND LIMITATIONS

Within the context of climate change, the green bond market and the UN's SDGs, this study addressed two main questions. Firstly, through the use of the event study methodology, the reaction of the market to the issuance of corporate climate action bonds issued globally was investigated. Further, the key factors that are correlated to the magnitude of the market's reaction was assessed through running a regression analysis, in which new factors that could offer valuable insight, were considered. This study is the first of its kind to view these questions through the lens of SDG 13: Climate Action, while simultaneously contributing to this new and under-researched field in a meaningful manner.

The finance and investment sectors have become a key arena for economies accelerating the transition to both sustainability and climate neutrality. Due to the large annual SDG investment gap of USD 2.5 trillion, coupled with the UN deadline for meeting these goals by 2030 fast approaching, it has become important to determine the extent of the role that green bonds can play in terms of mobilising financial resources, while involving the private sector in the global effort to achieve the SDG's. This study intended to shed light on the market's reaction to (and hence, indirectly, perception of) these instruments, which largely affects their success in both contributing positively to environmental initiatives, as well as closing the SDG funding gap. The results of this investigation could assist in understanding the challenges associated with using green bonds to finance environmental initiatives, specifically with regards to the market's reaction to their issuance.

Using 276 corporate climate action bonds issue announcements by listed companies across the world from 2007 to 2022, the findings reveal a positive abnormal equity return of issuers on the null (announcement) day. However, subsequent to the null day, a significant negative trend is observed which could illustrate the uncertainty and riskiness still associated with this new financial innovation. This reaction can possibly be explained through the potential signal of a certain degree of insecurity regarding future profitability prospects resulting from operational and capital outflows associated with green bonds. A negative cumulative average abnormal return implies that an announcement of the issuance of a corporate climate action bond has a negative effect on the stock prices of issuers.

The implications of this study concern three main groups: companies, investors and environmental advocates. Thus, the negative reaction observed subsequent to the null day could potentially indicate a) a need for companies wishing to use green bonds to educate the market regarding the benefits, use and role of these instruments, b) the acceptance and enthusiasm with regards to these bonds may not yet be strong among investors (who could value higher returns more than environmental initiatives) and/or c) that investors do not trust that the proceeds of these bonds will be appropriately used or may not increase the value of the issuing company.

This evidence suggests that these types of climate action debt offerings convey unfavourable information about the issuing firms to the market, subsequent to the null (announcement) day. Naturally, if this is the case, the market will likely divert finances away from these instruments, thereby making their effectiveness in terms of closing the SDG investment gap more challenging. As a result, companies that have introduced these instruments either to better their environmental ethical profile or as a way to fulfil financial targets may need to reevaluate and adjust their current views, potentially through communicating with the market in a way that convinces them of the value of these projects.

Despite the positive cumulative abnormal returns that this study found on the null day, which is in accordance with that of the studies conducted by Flammer (2021), Tang and Zang (2020), Kuchin et al. (2019), Wang et al. (2020) and Glavas (2018), cumulative abnormal returns for the entire even window, $[-10,10]$, and the null day onwards, $[0,10]$, were found to be -0.8% and -2.6% , respectively. Among the studies discussed in Chapter 2 that of Lebel et al. (2020) was the only one to find similar results, stating that the cumulative abnormal returns ranged between -0.5% and -0.2% , depending on which asset pricing model was used for the calculation.

These results also matched the expectations in terms of the outlined hypothesis in Chapter 2, which states that the announcement of the issuance of climate action bonds induces abnormal share price returns. Despite certain aspects of green bonds pointing to negative market responses to these instruments (e.g., the discussion of greenwashing, the potential of green bonds to lower the profitability of the issuing company, as well as the uncertainty and risk associated with these instruments), the overall negative response to climate action bonds was not anticipated, given the abundance of evidence of these instruments as positive change-makers.

Examining the issue in more detail, two main characteristics related to the issuing firm were found to exert distinct influences on the value effects associated with issuing climate action bonds. Specifically, the profitability of the issuing firm and the first versus subsequent issuance variables were both found to be statistically significant factors in the 11-day event window regression. Due to the signs associated with the variables, it can be said that the stock markets' negative response to climate action bond issuance announcements is alleviated when the company displays higher profitability levels and is issuing these types of green bonds for the first time, both for the 11-day event window. This evidence could offer companies a set of variables for climate action bonds that are worth assessing and ranking as part of their financial strategy and could further highlight the need to convince the market that the projects these bonds support are value-adding and beneficial to society.

Further, the results of these variables agree with the findings of the studies conducted by Pederson and Thun (2019) and Baulkaran (2019), which found the first versus subsequent variable and the profitability variable to be statistically significant. The findings of the aforementioned studies formed the basis for the variables' hypotheses presented in Chapter 2. However, only the profitability variable matched the stated expectations.

The remaining tested variables, namely the size of the issuer, the time variable, the ESG disclosure score, the governance score, the environmental score and the EPI score, did not have statistically significant relationships with cumulative abnormal returns within the regression models. It is worth highlighting that even though the environmental and governance disclosure scores do not significantly impact the performance of climate action bonds, these factors should, due to their importance, be reviewed once more if new information becomes available in the future.

In order to achieve the SDGs and other environmental targets, companies have to reduce their environmental footprint. Despite the overall negative cumulative abnormal returns observed within the 11-day short term window subsequent to the null day, the findings of this study imply that companies need to increase the market's confidence in the ability of these instruments to provide beneficial and successful environmental change. If the market is convinced, the private sector's role in closing the SDG funding gap could be significant, thereby concurring with the expectations outlined in Chapter 1.

In terms of solving the issue of the negative market reaction itself, the aforementioned parties should consider educating the market around the benefits of issuing such instruments, especially highlighting the role that investors could play in achieving certain environmental goals, such as the SDGs. Further, particular importance should be placed on creating good, long-lasting relationships between investors and issuing companies so that the market has a level of trust within this specific industry and does not need to factor the risk of i.e. greenwashing into their investment decision making process.

The limitations of this study are primarily data driven. Firstly, the green bond market is relatively new, with most of its growth and development taking place over the past 10 years. As a result, historical data is limited and analyses spanning more than the 13 years since its inception cannot be conducted. Secondly, within this study, only green bonds issued by public listed companies are analysed, while unlisted companies and government agencies are excluded due to a lack of data. Leaving out a possibly significant portion of this market has the potential to impact the overall results of the study. Thirdly, the results of this investigation are largely based on the developed world due to this being where the vast majority of the climate change bonds have been issued to date. Consequently, the results of this analysis may not be accurate when applied to developing economies. Finally, in this study, only climate action bonds that possess ESG disclosure scores are examined. This significantly reduced the sample due to many companies issuing these bonds not yet having an associated ESG disclosure.

Although this study covers most bond, firm and country specific characteristics found in the literature as factors correlated to bond announcement abnormal returns, further research may be performed to revisit certain characteristics, e.g. the environmental and governance scores, when more information becomes available in the future. Further, expanding the array of factors within the three categories could also be an avenue for future research – for example, including a third-party certification variable. This would result in a more thorough analysis of the effectiveness of corporate climate action bonds which could assist in bridging the knowledge gap between bonds, in general, and green bonds, in particular. Further, lateral growth is also feasible as green bond structures become more complex (e.g., including a variable stating whether the green bond is callable or not). Lastly, further research might examine how the company's other debt instruments are affected by the issuance of green bonds, i.e., whether they improve or impair the company's ability to issue further conventional bonds and whether they raise or lower the total cost of financing.

REFERENCES

- Ali, A. (2021, December 13). *Green Bonds: Lasting Solutions for Climate Change*. Visual Capitalist. <https://www.visualcapitalist.com/sp/green-bonds-lasting-solutions-for-climate-change/>
- Baker, M., Bergstresser, D., Serafeim, G., & Wurgler, J. (2018, April 27). *Financing the response to climate change: The pricing and ownership of US green bonds*. National Bureau of Economic Research. <https://www.brookings.edu/wp-content/uploads/2018/07/Wurgler-J.-et-al..pdf>
- Bachelet, M. J., Becchetti, L., & Manfredonia, S. (2019). The green bonds premium puzzle: The role of issuer characteristics and third-party verification. *Sustainability*, 11(4), 1098.
- Ball, R., & Brown, P. (1968). An empirical evaluation of accounting income numbers. *Journal of Accounting Research*, 6(2), 159-178.
- Baulkaran, V. (2019). Stock market reaction to green bond issuance. *Journal of Asset Management*, 20(5), 331-340.
- Binder, J. (1998). The event study methodology since 1969. *Review of Quantitative Finance and Accounting*, 11(1), 111-137.
- Burton, A. L. (2021). OLS (Linear) regression. *The encyclopedia of research methods in criminology and Criminal Justice*, 2, 509-514.
- Carolina Rezende de Carvalho Ferreira, M., Amorim Sobreiro, V., Kimura, H., & Luiz de Moraes Barboza, F. (2016). A systematic review of literature about finance and sustainability. *Journal of Sustainable Finance & Investment*, 6(2), 112-147.
- Cheong, C., & Choi, J. (2020). Green bonds: A survey. *Journal of Derivatives and Quantitative Studies: 선물연구*, 28(4), 175-189.
- Chin, S. K., & Abdullah, N. A. (2013). Announcements effect of corporate bond issuance and its determinants. *Contemporary Economics*, 7(1), 5-18.
- Climate Bonds Initiative. (2018, June 20). *Green Bonds – A Bridge to the SDG's*. ClimateBonds.net. https://www.climatebonds.net/files/reports/green-bonds_a-bridge-to-the-sdgs_062018.pdf
- Climate Bonds Initiative. n.d.a. *Explaining Green Bonds*. ClimateBonds.net. <https://www.climatebonds.net/market/explaining-green-bonds>
- Climate Bonds Initiative. n.d.b. *Understanding Climate Bonds*. ClimateBonds.net. <https://www.climatebonds.net/resources/understanding>
- Deng, Z., Tang, D. Y., & Zhang, Y. (2020). Is “greenness” priced in the market? Evidence from green bond issuance in China. *The Journal of Alternative Investments*, 23(1), 57-70.

- Environmental Performance Index. (2022, July 14). *About the EPI*. <https://epi.yale.edu/>
- Fama, E. F. (1970). Efficient capital markets: A review of theory and empirical work. *The Journal of Finance*, 25(2), 383-417.
- Fama, E. F. (1991). Efficient capital markets: II. *The Journal of Finance*, 46(5), 1575-1617.
- Fama, E. F., & French, K. R. (2004). The capital asset pricing model: Theory and evidence. *Journal of Economic Perspectives*, 18(3), 25-46.
- Flammer, C. (2021). Corporate green bonds. *Journal of Financial Economics*, 142(2), 499-516.
- Gianfrate, G., & Peri, M. (2019). The green advantage: Exploring the convenience of issuing green bonds. *Journal of Cleaner Production*, 219(1), 127-135.
- Glavas, D. (2018). How do stock prices react to green bond issuance announcements?. *Glavas, D.(2020). Green Regulation and Stock Price Reaction to Green Bond Issuance. Finance*, 1(1), 7-51.
- Hays, P. A., & Upton, D. E. (1986). A shifting regimes approach to the stationarity of the market model parameters of individual securities. *Journal of Financial and Quantitative Analysis*, 21(3), 307-321.
- Heinkel, R., Kraus, A., & Zechner, J. (2001). The effect of green investment on corporate behavior. *Journal of Financial and Quantitative Analysis*, 36(4), 431-449.
- Hvidkjær, S. (2017, September). *ESG investing: A literature review*. Dansif. <https://dansif.dk/wp-content/uploads/2019/01/Litterature-review-UK-Sep-2017.pdf>
- Jegadeesh, N., & Titman, S. (1993). Returns to buying winners and selling losers: Implications for stock market efficiency. *The Journal of Finance*, 48(1), 65-91.
- Kapraun, J., Latino, C., Scheins, C., & Schlag, C. (2021, April). (In)-credibly green: Which bonds trade at a green bond premium?. In *Proceedings of Paris December 2019 Finance Meeting EUROFIDAI-ESSEC*.
- Karpf, A., & Mandel, A. (2017, February 24). *Does it pay to be green?*. SSRN. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=2923484
- Katori, T. (2018, May 8). *The Financial Potential of Green Bonds: Comparing the Three Issuing Schemes*. SSRN. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3158890
- Kuchin, I., Baranovsky, G., Dranev, Y., & Chulok, A. (2019, January). Does green bonds placement create value for firms?. *Higher school of economics research paper No. WP BRP*, 101.

- Lebelle, M., Lajili Jarjir, S., & Sassi, S. (2020). Corporate green bond issuances: An international evidence. *Journal of Risk and Financial Management*, 13(2), 25.
- Maitra, D., & Dey, K. (2012). Dividend announcement and market response in Indian stock market: An event-study analysis. *Global Business Review*, 13(2), 269-283.
- Maltais, A., & Nykvist, B. (2020). Understanding the role of green bonds in advancing sustainability. *Journal of Sustainable Finance & Investment*, 1-20.
- Markovitz, H. M. (1959). *Portfolio selection: Efficient diversification of investments*. (ed.2). John Wiley.
- Merton, R. C. (1987). A simple model of capital market equilibrium with incomplete information. *Journal of Finance*, 42(3), 483-510.
- Mocanu, M., Constantin, L. G., & Cernat-Gruici, B. (2021). Sustainability bonds. An international event study. *Journal of Business Economics and Management*, 22(6), 1551.
- Moyer, J. D., & Hedden, S. (2020). Are we on the right path to achieve the sustainable development goals?. *World Development*, 127, 104749.
- Pedersen, A., & Thun, J. E. (2019). *Stock market reaction to green bond announcements: an empirical study on firms listed on European stock exchanges* (Master's thesis: Norwegian School of Economics). NHH Brage. <https://openaccess.nhh.no/nhh-xmlui/handle/11250/2644200?locale-attribute=no>
- Pettengill, G. N., & Clark, J. M. (2001). Estimating expected returns in an event study framework: Evidence from the dartboard column. *Quarterly Journal of Business and Economics*, 40(3), 3-21.
- Serra, A. P. (2004). Event study tests: A brief survey. *Gestão. Org-Revista Eletrônica de Gestão Organizacional*, 2(3), 248-255.
- Tang, D. Y., & Zhang, Y. (2020). Do shareholders benefit from green bonds?. *Journal of Corporate Finance*, 61(3), 101427.
- Țițan, A. G. (2015). The efficient market hypothesis: Review of specialized literature and empirical research. *Procedia Economics and Finance*, 32, 442-449.
- UNCTAD. (2014, May 3). *Developing Countries Face \$2.5 Trillion Annual Investment Gap in Key Sustainable Development Sectors, UNCTAD Report Estimates*. UNCTAD.org. <https://unctad.org/press-material/developing-countries-face-25-trillion-annual-investment-gap-key-sustainable>
- United Nations. (2017, December 28). *Human Security: Building Resilience to Climate Threats*. UN.org. <https://www.un.org/humansecurity/wp-content/uploads/2017/10/Human-Security-and-Climate-Change-Policy-Brief-1.pdf>

- United Nations. (2019, September 26). *Attaining Sustainable Development Goals by 2030 Will Be Impossible at Current Investment Rate, Deputy Secretary-General Tells Global Compact CEO Event*. UN.org. <https://www.un.org/press/en/2019/dsgsm1347.doc.htm>
- United Nations Climate Change. (2021, February 26). *A Beginners Guide to Climate Neutrality*. <https://unfccc.int/blog/a-beginner-s-guide-to-climate-neutrality>
- United Nations Development Program. n.d. *The SDG's in Action*. UN.org. <https://www.undp.org/sustainable-development-goals>
- Wang, J., Chen, X., Li, X., Yu, J., & Zhong, R. (2020). The market reaction to green bond issuance: *Evidence from China*. *Pacific-Basin Finance Journal*, 60(1), 101294.
- Woon, W. S. (2004). Introduction to the event study methodology. *Singapore Management University*, 4(7), 1-12.
- World Economic Forum. (2021, December 14). *The Global Risks Report 2021*. WEFForum.org. https://www3.weforum.org/docs/WEF_The_Global_Risks_Report_2021.pdf
- Zerbib, O. D. (2019). The effect of pro-environmental preferences on bond prices: Evidence from green bonds. *Journal of Banking & Finance*, 98(1), 39-60.

APPENDIX A: DIAGNOSTIC TESTS FOR OLS ASSUMPTIONS

APPENDIX A.1: Linearity

This table shows the results of testing the first OLS assumption, linearity, which determines whether there is a linear relationship between the independent and dependent variable within the regression analysis by examining the equations of the observed predicted value graphs.

<i>Equation</i>								
<i>Regression</i>	<i>Size of the Issuer</i>	<i>Profitability</i>	<i>First vs Subsequent</i>	<i>EPI</i>	<i>ESG Disclosure Score</i>	<i>(E) Score</i>	<i>(G) Score</i>	<i>Time Dummy</i>
(1) 1-Day ESG	$y = 5.6034x - 0.0072$	$y = -0.8765x + 0.0011$	$y = -2.6653x + 0.0034$	$y = 1.2218x - 0.0016$	$y = -2.2966x + 0.003$	N/A	N/A	N/A
(2) 11-day ESG	$y = 0.1861x + 0.0012$	$y = 2.8512x + 0.0177$	$y = -1.7276x - 0.0107$	$y = 0.7077x + 0.0044$	$y = -0.3514x - 0.0022$	N/A	N/A	N/A
(3) 1-Day E & G	$y = 5.6034x - 0.0072$	$y = -0.8765x + 0.0011$	$y = -0.8765x + 0.0011$	$y = 1.2218x - 0.0016$	N/A	$y = -2.2857x + 0.003$	$y = -3.4615x + 0.0045$	N/A
(4) 11-day E & G	$y = 0.1861x + 0.0012$	$y = 2.8512x + 0.0177$	$y = -1.7276x - 0.0107$	$y = 0.7077x + 0.0044$	N/A	$y = -0.0573x - 0.0004$	$y = -0.4326x - 0.0027$	N/A
(5) 1-Day Time Dummy ESG	$y = 5.6034x - 0.0072$	$y = -0.8765x + 0.0011$	$y = -2.6653x + 0.0034$	$y = 1.2218x - 0.0016$	$y = -2.2966x + 0.003$	N/A	N/A	$y = 2.2275x - 0.0043$
(6) 11-day Time Dummy ESG	$y = 0.1861x + 0.0012$	$y = 2.8512x + 0.0177$	$y = -1.7276x - 0.0107$	$y = 0.7077x + 0.0044$	$y = -0.3514x - 0.0022$	N/A	N/A	$y = 0.0222x - 0.0013$

APPENDIX A.2: Independence

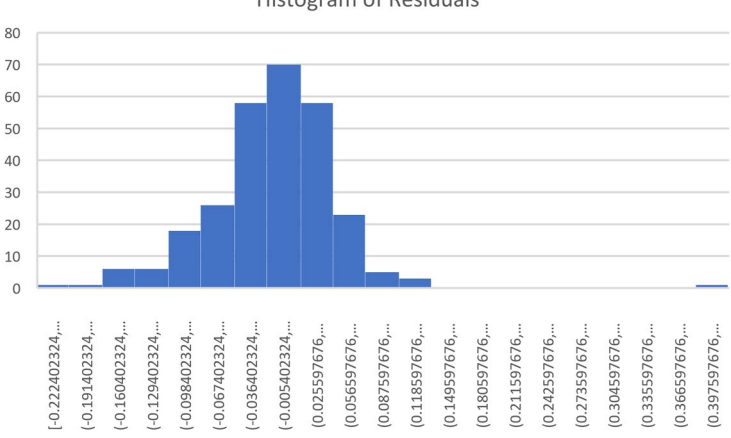
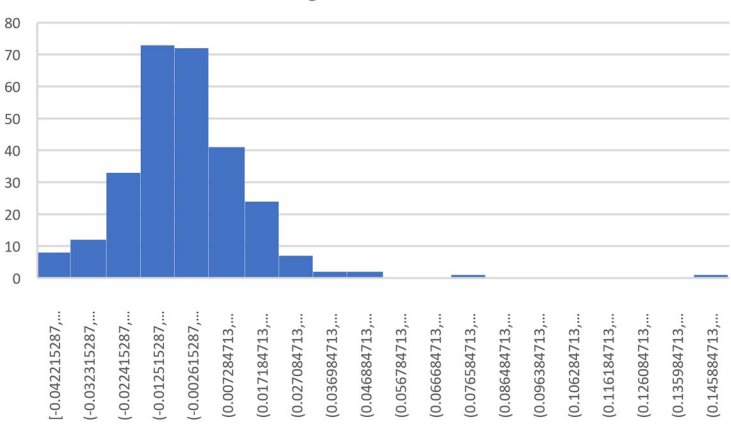
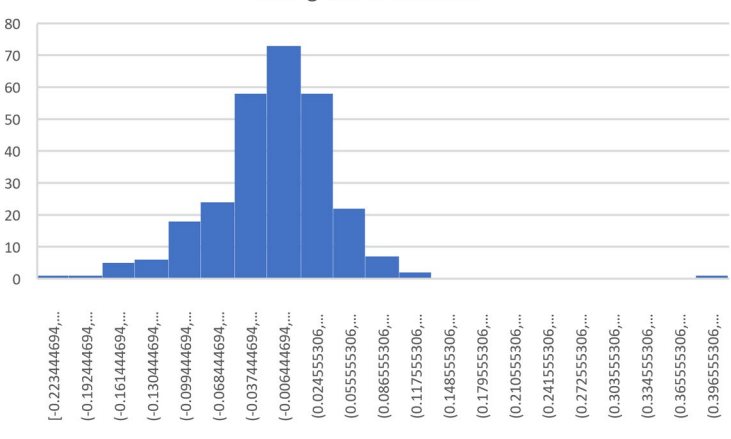
This table shows the results of testing the second OLS assumption, independence, which determines whether the independent variables included in the analysis are correlated with each other by calculating the Durbin-Watson statistic.

<i>Regression</i>	<i>Durbin-Watson Statistic</i>
(1) 1-Day ESG	2.1568
(2) 11-day ESG	1.8060
(3) 1-Day E & G	2.1621
(4) 11-day E & G	1.8152
(5) 1-Day Time Dummy ESG	2.1550
(6) 11-day Time Dummy ESG	1.8042

APPENDIX A.3: Normality

These graphs show the results of testing the third OLS assumption, normality, which determines whether the residuals are normally distributed through visually inspecting the plots.

<i>Regression</i>	<i>Graph</i>
1-Day ESG	Histogram of Residuals [-0.041701711,... (-0.031801711,... (-0.021901711,... (-0.012001711,... (-0.002101711,... (0.007798289,... (0.017698289,... (0.027598289,... (0.037498289,... (0.047398289,... (0.057298289,... (0.067198289,... (0.077098289,... (0.086998289,... (0.096898289,... (0.106798289,... (0.116698289,... (0.126598289,... (0.136498289,... (0.146398289,...
11-day ESG	Histogram of Residuals [-0.22351612,... (-0.19251612,... (-0.16151612,... (-0.13051612,... (-0.09951612,... (-0.06851612,... (-0.03751612,... (-0.00651612,... (0.02448388,... (0.05548388,... (0.08648388,... (0.11748388,... (0.14848388,... (0.17948388,... (0.21048388,... (0.24148388,... (0.27248388,... (0.30348388,... (0.33448388,... (0.36548388,... (0.39648388,...
1-Day E & G	Histogram of Residuals [-0.04164294,... (-0.03174294,... (-0.02184294,... (-0.01194294,... (-0.00204294,... (0.00785706,... (0.01775706,... (0.02765706,... (0.03755706,... (0.04745706,... (0.05735706,... (0.06725706,... (0.07715706,... (0.08705706,... (0.09695706,... (0.10685706,... (0.11675706,... (0.12665706,... (0.13655706,... (0.14645706,...

11-day E & G	Histogram of Residuals 
1-Day Time Dummy ESG	Histogram of Residuals 
11-day Time Dummy ESG	Histogram of Residuals 

APPENDIX A.4: Constant Error Variance

This table shows the results of testing the fourth OLS assumption, constant error variance, which determines whether the variance of the predicted value of the error is constant through calculating the Chi-Squared test statistic.

<i>Regression</i>	<i>Chi Squared Test Statistic</i>	<i>P Value</i>
(1) 1-Day ESG	2.4892	0.7781
(2) 11-day ESG	4.8590	0.4333
(3) 1-Day E & G	2.5846	0.7637
(4) 11-day E & G	5.7297	0.3334
(5) 1-Day Time Dummy ESG	3.6684	0.5981
(6) 11-day Time Dummy ESG	5.7216	0.3343

APPENDIX A.5: Multicollinearity

This table shows the results of testing the fifth OLS assumption, multicollinearity, which determines whether there is a linear relationship between the independent variables through calculating the Variance Inflation Factors.

<i>Variance Inflation Factors</i>								
<i>Regression</i>	<i>Size of Bond the Issuer</i>	<i>Profitability</i>	<i>First vs Subsequent</i>	<i>EPI</i>	<i>ESG Disclosure Score</i>	<i>(E) Score</i>	<i>(G) Score</i>	<i>Time Dummy</i>
(1) 1-Day ESG	1.1341	1.0452	1.0186	1.1469	1.0312	N/A	N/A	N/A
(2) 11-day ESG	1.1341	1.0452	1.0186	1.1469	1.0312	N/A	N/A	N/A
(3) 1-Day E & G	1.1441	1.0388	1.0489	1.1618	N/A	1.1989	1.1779	N/A
(4) 11-day E & G	1.1441	1.0388	1.0489	1.1618	N/A	1.1990	1.1779	N/A
(5) 1-Day Time Dummy ESG	1.1353	1.0492	1.0215	1.2138	1.0368	N/A	N/A	1.0796
(6) 11-day Time Dummy ESG	1.1353	1.0492	1.0215	1.2138	1.0368	N/A	N/A	1.0796