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Erasmus School of Economics

Master Thesis [Financial Economics]

The effect of green bond issuance on short- and long-term firm performance and the cost of debt capital of the issuing firm in the future

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Abstract

This research examines the effect of green bond issuance on short- and long-term firm performance and the cost of debt capital of the issuing firm in the future. Bloomberg's Fixed Income database is used to find European and United States companies and governments that have issued green bonds between 2015 and 2022 and to obtain data on the characteristics of the bonds. In addition, Standard & Poor's CompuStat North America and Global databases are used to obtain the financial data of the firms. The treatment group contains the green bond issuing companies and the control group contains the other companies. To test the hypotheses, Difference-in-Differences regressions without fixed effects, with industry, country and year fixed effects and with firm and year fixed effects are used. From these regressions, the best-fitting model is selected, which is performed with the first, second and third leads of the short- and long-term firm performance variables instead of the contemporary ones. For the future cost of debt capital, regressions are performed with the first to the fifth leads of the cost of debt capital variable instead of the contemporary ones. The results show that there is a positive relationship between green bond issuance and short-term firm value, but no relationship between green bond issuance and long-term financial performance. In addition, there is a positive relationship between green bond issuance and the cost of debt capital of the issuing firm in the future.

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1 Introduction

There is a growing awareness that there are pressing environmental problems in the world, which could have major consequences for the future (Banga, 2019; Fatica, Panzica and Rancan, 2021). Governments are paying more and more attention to these problems, but this phenomenon is also visible in the corporate community and the financial sector. In the past, investors did not care much about what happened to the money they invested as long as it generated a profit, but nowadays they take the negative impact on the environment into account when making their investment decisions (Yeow and Ng, 2021). In addition, governments and activist groups are increasingly calling for an end to the environmental crisis. This led to many countries signing the Paris Agreement in 2015, which means that countries must commit to limiting the average global temperature increase on earth to 1.5 to 2 degrees Celsius, and the United Nations' Sustainable Development Goals, which are seventeen goals that aim to make the earth a better place to live in by 2030. In addition, there is the European Climate Law, which means that the European Union will be climate neutral by 2050. This means that businesses also have to become more sustainable and reduce their CO2 emissions, especially companies that make extensive use of fossil energy sources. The question is how they can reach this objective.

As a relatively new financial instrument, green bonds could play a major role in combating the climate crisis and can help with the energy transition and making companies more sustainable (Gianfrate and Peri, 2019; Zerbib, 2019). Green bonds are defined as fixed income bonds that are issued to raise funds that are used to finance and stimulate environmentally-friendly and climate-friendly projects (Flammer, 2021). The issuances of green bonds have increased considerably in recent years (Maltais and Nykvist, 2020). In 2014 the green bond market was only 37 billion US dollars, in 2017 it was already 159 billion US dollars and in 2021 the highest amount was reached, namely 582 billion US dollars (Climate Bonds Initiative, 2022). In 2007, the first green bond, namely the Climate Awareness Bond, was issued by the European Investment Bank. At the time, this was still a relatively unknown financial instrument, which caused fear of greenwashing among investors (Flammer, 2021). Nowadays, there are a number of unofficial guidelines and standards for issuing green bonds that help and give direction to companies and investors. For example, there are the Green Bond Principles of the International Capital Market Association and the Climate Bonds Standard of the Climate Bonds Initiative (CBI). In addition, issuing companies can have their bond assessed by and request a certificate from a third party to demonstrate that the bond is truly 'green'. Companies that want to comply with the Climate Bonds Standard of the CBI are required to apply for a Climate Bonds Certificate (Hyun, Park and Tian, 2020). As a result, confidence in green bonds has increased and the green bond market has grown significantly.

To comply with the Paris Agreement and the European Climate Law, large amounts of funds are required that must be used in a sustainable and efficient manner to combat further climate change as much as possible (Zerbib, 2019; Maltais and Nykvist, 2020). Green bonds can help companies and governments gain easier access to capital (Oikonomou, Brooks and Pavelin, 2014) and at a lower cost of debt in a short period of time (Gianfrate and Peri, 2019). In addition, it is becoming increasingly popular among investors to invest in green projects, including green bonds (Yeow and Ng, 2021; Banga, 2019). The issuance of green bonds receives a lot of media attention, which attracts the attention of (green) investors, who otherwise would not have heard of the company (Tang and Zhang, 2020). This increases the investor demand for green bonds, which could encourage companies to issue more of them (Flammer, 2021).

The funds that the company obtains from the issuance of green bonds, can be invested in researching and developing new sustainable technology for the company and therefore lead to green innovation (Wang, Liu and Wang, 2022). This can improve the environmental performance and can make companies more sustainable and ensure that they become climate neutral over time (Yeow and Ng, 2021; Maltais and Nykvist, 2020). This is a positive development for preserving the environment, but investing in green technology is sometimes quite experimental and risky, so if the desired result is not achieved, the value of the company could decrease and this could ultimately lead to bankruptcy (Tan, Dong, Liu, Su and Li, 2022). In addition, when issuing green bonds, companies must apply for a certificate, which requires an independent report form a third party, and must regularly disclose extensive, high-quality information about the goal it wants to achieve and the investments made with the green bond funds, which makes the issuance more expensive than conventional bond issuance (Immel, Hachenberg, Kiesel and Schiereck, 2020). So the question is whether the issuance of green bonds benefits companies financially. My research question is therefore:

"What is the effect of green bond issuance on short- and long-term firm performance and the cost of debt capital of the issuing firm in the future?"

This research can add to the existing literature, because previous research has mainly focused on ESG (environmental, social and governance) and its effect on the financial performance of the company and on the pricing of green bonds and the bond premium relative to conventional bonds. Green bonds are a fairly new financial instrument, so less research has been done on the effect of green bonds on long-term value creation of firms and the future cost of debt capital, which is done in this research. In addition, multiple measures of both short- and long-term firm performance are used in the regressions and multiple robustness checks are performed to examine whether the results are significant. Moreover, I use recent data and more control variables than other studies. So this research is scientifically relevant, because it contributes

to and extends the existing literature.

This research is also socially relevant, because the theme of green investment is very topical among investors and companies at the moment. There is increasing attention for climate problems. As a result, some investors prefer to invest in sustainable companies. After more research, it can become clear whether investing in green bonds really ensures that the environmental performance of companies increases and if it is also a profitable investment for investors. The results of the research can also clarify whether issuing green bonds provides the company with financial benefits and a lower cost of debt capital and as a result, it can lead to recommendations on whether issuing green bonds is beneficial for the company. If research shows that it is beneficial for both companies and the environment (a win-win situation), then a recommendation can be made to the government to refund the issuance costs and the costs of requesting a certificate to companies, in order to encourage the issuance of green bonds. This ensures that the management of the firm becomes familiar with and sees the advantages of sustainability and green bonds and that both the global climate goals can be achieved and economic prosperity is created for society.

To answer the research question, Bloomberg's Fixed Income database is used to find European and United States (US) companies and governments that have issued green bonds between January 1, 2015 and December 31, 2022. The same database is used to find companies that have issued conventional bonds and to obtain data on the characteristics of the green and conventional bonds. In addition, Standard & Poor's CompuStat North America database is used to get data from the financial statements about the US firms and Standard & Poor's CompuStat Global database to obtain financial data on the European firms. The companies that have issued green bonds are the treatment group of this research and the companies that do not issue green bonds are the control group. To test the hypotheses, Difference-in-Differences (DiD) regressions without fixed effects, with industry, country and year fixed effects and with firm and year fixed effects are used. From these regressions, the best-fitting model is selected, which is performed with the first, second and third leads of the short- and long-term firm performance variables instead of the contemporary ones as a robustness check. For the future cost of debt capital, regressions are performed with the first, second, third, fourth and fifth leads of the cost of debt capital variable instead of the contemporary ones as a robustness check.

The results show that there is a statistically significant positive relationship between green bond issuance and both Tobin's Q and Return on equity (ROE) (short-term firm value) and that this effect is even larger in the long term. However, there is no statistically significant relationship between green bond issuance and both Return on assets (ROA) and Return on sales (ROS) (long-term financial performance). In addition, the results show that there is a statistically significant positive relationship between green bond issuance and cost of total debt

and that this effect persists in the long term.

The structure of this research is as follows. In section 2, I discuss the existing literature and develop three hypotheses. In section 3, the data, sample selection and descriptive statistics are discussed. In section 4, the methodology is explained. In section 5, the results and robustness checks are presented. Finally, in section 6 the conclusion and discussion follow.

2 Literature review

2.1 The effect of green bond issuance on short-term firm value

There is a growing awareness in society that we need to treat the environment better and put an end to the climate crisis (Banga, 2019; Renneboog, Ter Horst and Zhang, 2008; Fatica et al., 2021). Investors also take their environmental concerns into account when making investment decisions (Hyun et al., 2020; Nguyen, Kecskés and Mansi, 2020). Thus, there are more and more investors who consciously opt for green investments in order to respond to their environmentally-friendly norms (Huang, 2022). As a result, more and more money is being spent on sustainable investments and less on projects aimed at short-term profits at the expense of the climate and the environment (Zerbib, 2019). This can therefore be an incentive for companies to issue green bonds, because the money received from green bonds must be spent on making the company more sustainable and reducing the carbon footprint (Flammer, 2021; Maltais and Nykvist, 2020) and there is a demand for this from investors (Maltais and Nykvist, 2020). The question is whether this is beneficial for the firm.

There is information asymmetry between investors and firms, because bearing (financial) risks and making decisions about the company are separated and not the same people are responsible for it. This is because shareholders hire managers, because they do not have the time and special skills to run the company. The problem that arises, is that the managers know more about what is going on in the company than the investors (Flammer, 2021) and they determine what information is made public (Huang, 2022). The solution that is used in practice to tackle this agency problem, is that there is a board of directors that supervises the management (Fama and Jensen, 1983). Nevertheless, the information advantage that the managers have can lead to adverse selection, which means that managers withhold information, so that not the best managers are retained and not the best decisions are made (Akerlof, 1970), or moral hazard, which means that managers make risky, overly expensive decisions, because they are not exposed to the risk and do not have to pay the costs of their actions (Marshall, 1976). As a result, it takes investors time and effort (transaction costs) to discover which companies are the best investment options (Akerlof, 1970). The firm can reduce information asymmetry by disclosing information, thereby sending a credible signal that it is a good choice for investors to invest in it. This signalling theory only works, if it is costly to falsify the signal and if it cannot be easily imitated by underperforming companies (Spence, 1973).

The signalling theory can be applied to green bond issuances. It is often difficult for investors to gauge whether companies are sustainable and are concerned about the environment, so it is not clear which firms they should invest in (Yeow and Ng, 2021; Hyun et al., 2020). Firms can signal to investors that they care about the environment by issuing green

bonds (Flammer, 2021; Lyon and Montgomery, 2015; Huang, 2022) and show that they are making the ('right') sustainable decision, which diminishes the adverse selection problem (Huang, 2022; Tang and Zhang, 2020; Ge and Liu, 2015). It is costly to falsify the signal, because the money received from green bonds, which is usually a high amount, must be put into making the company more sustainable and reducing the carbon footprint and cannot be used for other investment projects (Zhou and Cui, 2019). In addition, companies often request a certificate from a third party, which confirms that the money is used to achieve the predetermined green goals (Tang and Zhang, 2020; Immel et al., 2020). This means that the company must comply with the rules and standards of the third party after obtaining the certificate, which costs the firm time, effort and money (Flammer, 2021). If the company does not do this, it must report it to the Climate Bonds Initiative and if it still does not meet the standards within a certain time, the green bond loses the certificate, which is likely to get bad media attention. This prevents greenwashing, which is defined as spreading unfounded and deceptive statements by the firm about its commitment to the environment, because bad media attention leads to a negative stock market reaction and applying for a certificate requires an independent report form a third party and the regular disclosure of information about the ESG policy of the firm and the investments made with the green bond funds, which is expensive (Flammer, 2021; Immel et al., 2020; Tang and Zhang, 2020). Thus, the cost of green bond issuance is quite high, so this gives investors confidence that the firm is spreading a credible signal and cares about the environment. The issuance of green bonds can therefore be a positive sign in the eyes of investors, which can have a positive effect on short-term firm value (Tang and Zhang, 2020). Flammer (2021) finds a positive relationship between green bonds and stock returns on the day of the issuance announcement.

In addition, it could be that investors accept a lower bond yield, because the funds from the green bonds go to environmentally-friendly projects (Flammer, 2021). Investors are then more willing to accept a lower cost of capital, allowing the company to finance sustainable investments more cheaply (Zerbib, 2019; Flammer, 2021) and in this way, it ensures that the resources go to the most rewarding investments, so that the money is used as efficiently as possible (Zhou and Cui, 2019; Yeow and Ng, 2021; Fatica et al., 2021). This can result in lower borrowing costs for the company and therefore higher profits. This leads to a higher profitability in the short term. Oikonomou et al. (2014) find a negative relationship between Corporate Social Performance (CSR) and cost of debt in the US.

So hypothesis 1 is: *“Green bond issuance has a positive direct effect on short-term firm value.”*

2.2 The effect of green bond issuance on long-term financial performance

Investing in green projects with the help of green bonds can lead to an enhancement in the environmental performance of companies. If the green project has a positive net present value (NPV) and the company really wants to contribute to the environment with the green bond, this can ensure that the firm can operate more efficiently (Flammer, 2021). This can be done, for example, by building a new sustainable factory, so that more output can be produced in an efficient and sustainable way (Zhou and Cui, 2019; Yeow and Ng, 2021) and by installing solar panels on the roofs of offices. This saves costs, both in the short- and long-term, for example by saving energy from fossil energy sources, which reduces companies' energy bills, and reducing CO2 and polluting emissions, which means companies have to buy fewer emission rights and pay less CO2 tax (Flammer, 2021; Yeow and Ng, 2021; Baulkaran, 2019; Zhou and Cui, 2019). This can lead to an increase in environmental performance and in turn to better financial performance due to the cost reductions, which increases the firm value in the long run (Yeow and Ng, 2021; Zhou and Cui, 2019).

In addition to making the company more sustainable, the money raised from green bonds can also be invested in researching and developing new sustainable technology for the company and therefore lead to green innovation (Wang et al., 2022; Tan et al., 2022). The issuance of green bonds makes it easier for companies to obtain financing for green investments (Khurram, Xie, Mirza and Tong, 2023; Wang et al., 2022). Investing in green technology is sometimes quite experimental and risky (Tan et al., 2022; Khurram et al., 2023), which means that the desired result is not always achieved or only after a long time (Wang et al., 2022) and it does not deliver financial performance in the short term (Khurram et al., 2023). As a result, these investments sometimes cannot be carried out, because suitable financing cannot be found, even though the projects are profitable. Green bonds could change this, because issuing them can attract the attention of certain investors, for whom these projects may be attractive (Tan et al., 2022). In this way, companies can still invest in sustainable technology, which can provide the company with patents (Tan et al., 2022). This ensures that the company has the sole right to use the technology, which can provide a competitive advantage (Khurram et al., 2023; Tan et al., 2022). This in turn can improve production efficiency, as it can reduce harmful emissions and energy consumption (Wang et al., 2022; Tan et al., 2022). This leads to an increase in the long-term performance of the firm and an improvement in the value of the company (Wang et al., 2022; Khurram et al., 2023).

Often, the issuance of green bonds is accompanied by environmentally friendly improvements that are implemented throughout the entire company (Flammer, 2021; Maltais and Nykvist, 2020; Yeow and Ng, 2021). This can also result in companies that are actively involved with the environment and corporate social responsibility, maintaining better relations

with stakeholders and society, because those are interested in the sustainable company and want to cooperate with the company, because they want to support their mission. This can lead to customers and suppliers remaining loyal to the company (Klein and Leffler, 1981; Maltais and Nykvist, 2020), the company being able to attract and retain a better work force, operating more efficiently and having better access to capital resources (Oikonomou et al., 2014; El Ghoul, Guedhami, Kwok and Mishra, 2011; Yeow and Ng, 2021). This gives the company a competitive advantage over other companies (Tan et al., 2022), because it has easier access to capital for future investments and a talented work force. In addition, it provides the company with brand awareness and a good name (Huang, 2022; Maltais and Nykvist, 2020), which leads to higher firm value and long-term financial performance.

Green bond issuances often receive media attention, because making companies more sustainable is seen as a good thing and also provides investors with new information regarding the future policy of the company (Tang and Zhang, 2020; Huang, 2022). This exposure brings the company to the attention of investors, who otherwise would not have heard of the company, increasing the demand for its bonds and stocks (Tang and Zhang, 2020; Zhang, Li and Liu, 2021; Khurram et al., 2023). As a result, the investor base enlarges, because companies that are involved in sustainability and enhance their environmental performance attract green investors and institutional investors, who believe that ESG is important (Flammer, 2021; El Ghoul et al., 2011; Baulkaran, 2019; Ge and Liu, 2015). Institutional investors want to invest funds in sustainable companies, because this way they can improve their ESG rating (Tang and Zhang, 2020), diversify the investments in their portfolios, so that risk decreases (Zhou and Cui, 2019; Banga, 2019; Febi, Schäfer, Stephan and Sun, 2018) and sustainable companies often have a better reputation, which reduces the risk of image damage for investors (Apergis, Poufinas and Antonopoulos, 2022; Renneboog et al., 2008). The rise in institutional ownership is a good thing, as it causes more trading in the financial markets, which enhances stock liquidity (Tang and Zhang, 2020). In addition, active institutional investors can improve the company's accounting performance (Dimson, Karakaş and Li, 2015) and can ensure that the downside risk decreases (Apergis et al., 2022; Tang and Zhang, 2020). Moreover, institutional investors keep stocks and bonds in their portfolio longer than other investors, so they do not immediately sell them when the price falls, which stabilizes the returns (Flammer, 2021; Nguyen et al., 2020; Khurram et al., 2023). An increase in institutional ownership therefore has many advantages, which in the long term ensures that the firm value increases.

It is also the case that long-term (institutional) investors can make the company more sustainable. Managers prefer visible results in the short term to show that the company is doing well. CSR is not measurable and only has an effect in the long term, which is why managers do not always devote enough attention and money to it, while it can generate profits for

investors (Nguyen et al., 2020; Wang et al., 2022). Managers and investors do not always have the same goal in mind for the company (incentive alignment problem) and managers are more focused on short-term performance without regard for the future of the company (investment myopia) (Stein, 1988). As a result, managers invest too much or too little in CSR (Bannier, Bofinger and Rock, 2022; Barth, Hübel and Scholz, 2022). Long-term investors can tackle this problem by keeping an eye on the managers and controlling their actions. It costs long-term investors less money and pays off more to collect a lot of information and influence the behaviour of managers than short-term investors (Nguyen et al., 2020). Institutional investors often hold a larger number of shares in the company than short-term investors and can influence the company's strategy by making their voice heard through their voting power in the annual general meeting of the shareholders. In addition, long-term investors can influence the policy of managers by threatening to sell their shares in the company, because this is a signal to the market that the company is not doing well, because long-term investors often have more information than other investors (Nguyen et al., 2020). In this way, long-term investors ensure that managers invest just enough money in sustainability, thereby maximizing long-term firm value. Nguyen et al. (2020) find that there is a positive relationship between long-term investors and shareholder value due to an increase in CSR, which is caused by a decrease in cash flow volatility.

As already mentioned in section 2.1, if the company credibly signals that it takes the environment seriously by issuing green bonds, this can improve the company's reputation. The issuance entails that the company has to share extensive, high-quality information with the investors about the goal it wants to achieve with the money from the green bonds in order to show that it is being socially responsible (Huang, 2022; Yeow and Ng, 2021; Maltais and Nykvist, 2020; Tang and Zhang, 2020). This ensures that, in addition to financial information, investors also receive information about the company's sustainability policy and next steps with regard to ESG (Yeow and Ng, 2021; Zhang et al., 2021; Khurram et al., 2023). The greater information transparency will diminish the information asymmetry between the investors and the green bond issuers (Yeow and Ng, 2021; Huang, 2022; Hyun et al., 2020; Fatica et al., 2021; Immel et al., 2020; Febi et al., 2018). In addition, the issue of green bonds and the green project that is financed with it, can provide media attention (Tang and Zhang, 2020; El Ghoul et al., 2011). As a result, the government may want to support the firm to achieve its green goal and investors and society may get a different view of the company (Huang, 2022; Sun and Cui, 2014; Tan et al., 2022; Ge and Liu, 2015). With the issuance of green bonds, the company can show that it is fully committed to the environment and a sustainable society and that it wants to change (Tang and Zhang, 2020). In this way, the (social) reputation of the company can improve in the eyes of the public, which can lead to an increase in the value of the company in the long run (Zhou and Cui, 2019; Baulkaran, 2019).

So hypothesis 2 is: *"Green bond issuance has a positive direct effect on long-term financial performance."*

2.3 The effect of green bond issuance on the future cost of debt capital

As already mentioned in section 2.1, green bonds can have a lower cost of debt than other forms of debt capital (Zerbib, 2019; Gianfrate and Peri, 2019). The money received from the issuance of green bonds is spent on environmentally-friendly investments and making the company more sustainable, ensuring that the company is ready for the future, now that the government is imposing regulations on companies to reduce their carbon footprint (Apergis et al., 2022). This leads to the company becoming less risky, because it already anticipates ESG regulations in the future and is therefore better prepared (Zerbib, 2019; Goss and Roberts, 2011; El Ghoul et al., 2011; Zhang et al., 2021). Sustainable companies also avoid being held liable by stakeholders for violating environmental regulations and being fined by the government (Tan et al., 2022). This ensures that the probability of the company going bankrupt decreases (Sun and Cui, 2014), which leads to a better credit rating (Jiraporn, Jiraporn, Boeprasert and Chang, 2014) and in turn lowers the cost of debt (Ge and Liu, 2015). Apergis et al. (2022) find that if the company has a higher ESG score, then the cost of debt is lower.

As already mentioned in section 2.2, a firm can improve its reputation by issuing green bonds which are put into green investments, which can increase the value of the firm in the long run (Zhou and Cui, 2019). This can lead to a stable stream of income and a less volatile stock price for the company, because the company's underlying assets are more stable and the risk of financial setbacks is lower (Oikonomou et al., 2014; Barth et al., 2022). This in turn can lead to less (credit) risk, because investors know and trust the company (Bannier et al., 2022; Oikonomou et al., 2014; Sun and Cui, 2014; Barth et al., 2022) and want to be associated with sustainable companies with a good reputation, but not with environmentally-unfriendly companies, because this can damage the investors' image and they can be held liable for the mistakes of the issuing company (Apergis et al., 2022). This can lower the cost of debt if the company borrows money in the future, for example because the credit rating has improved (Ge and Liu, 2015) and as a result, the default risk has decreased (Goss and Roberts, 2011; Apergis et al., 2022; Sun and Cui, 2014; Gigante and Manglaviti, 2022).

As already mentioned in section 2.2, companies that issue green bonds are also often more socially and environmentally involved with stakeholders and society, enabling them to attract a better work force, operate more efficiently and have better access to sources of capital than companies that are not socially responsible (El Ghoul et al., 2011; Apergis et al., 2022; Maltais and Nykvist, 2020). This gives them a competitive advantage and a lower probability of default (Sun and Cui, 2014; Barth et al., 2022), which leads to a lower cost of debt

(Oikonomou et al., 2014).

So hypothesis 3 is: *“Green bond issuance has a negative direct effect on the cost of debt capital of the issuing firm in the future.”*

3 Data

3.1 Sample selection

The sample consists of European and US companies and governments that have issued green bonds during the sample period, which runs from January 1, 2015 to December 31, 2022. Bloomberg's Fixed Income database is used to find the companies and governments that issued green bonds during this period. Table 1 summarizes the sample selection process.

Table 1 Sample selection process

Selection criteria	**Number of bonds**
Initial sample of active corporate and government bonds on October 1, 2023	453,994
Include: Bonds issued between January 1, 2015 and December 31, 2022	284,192
Include: Bonds whose country of incorporation is Europe or the US	132,445
Include: Green bonds	3,025

The initial sample consists of active corporate and government bonds. Firstly, I only add bonds to the sample that were issued between January 1, 2015 and December 31, 2022. Secondly, I only include bonds that have Europe or the US as their country of incorporation, in order to get the European and US bonds. Thirdly, I select the bonds that have 'Green bond' as their use of proceeds. The number of green bonds remaining after the sample selection process is 3,025 bonds. In order to compare the amounts, all bond variables are converted into US dollars.

Table 2 shows the growth in the number and amount of European and US green bonds issued over the years. It can be seen that the number and amount of European and US green bonds has increased enormously between 2015 and 2021, from 12.2 billion to 424 billion US dollars. In 2019, the number of issuances even more than doubled compared to the previous year, from 145 green bond issuances to 342 issuances. In 2022, a small decrease is visible in both the number and amount compared to 2021. This could mean that the issuance of green bonds by companies and governments has reached its peak, but this cannot be said with certainty without this year's data. Perhaps it is due to deteriorating economic conditions and the number may continue to rise in the coming years.

Table 2 The number and amount of European and US green bonds between 2015 and 2022

Year	Number of green bonds	Amount of green bonds in billions of US dollars
2015	86	12.2
2016	59	23.2
2017	98	78.1
2018	145	70.9
2019	342	148
2020	542	194
2021	900	424
2022	773	267
Total	2,945	1,220

Table 3 shows the number and amount of European and US green bonds issued by industry.

Table 3 The number and amount of European and US green bonds by industry

Industry	Number of green bonds	Amount of green bonds in billions of US dollars
Communications	23	18
Consumer Discretionary	72	44.7
Consumer Staples	33	12.4
Energy	117	15.3
Financials	1,667	397
Government	366	428
Health Care	12	5.14
Industrials	123	37.2
Materials	59	24.7
Technology	9	6.91
Utilities	464	227
Total	2,945	1,220

The highest number of green bonds was issued by the financial sector, but the largest amount was achieved by the public sector. More green bonds are therefore issued in the financial sector, but for a lower amount issued than by the government. Green bonds are also widely used in the utilities sector, which is not surprising, since these companies will have to make significant efforts to become more sustainable in the coming years. The fewest green bonds are issued by the technology, health care, communications and consumer staples sector, which

is probably the case, because these sectors are essential to society and therefore under the least pressure to implement sustainable reforms.

Table 4 shows the number and amount of European and US green bonds issued by country.

Table 4 The number and amount of European and US green bonds by country

Country	**Number of green bonds**	**Amount of green bonds in billions of US dollars**
Austria	59	16.7
Belgium	30	26
Czech Republic	3	1.5
Denmark	42	23.2
Finland	37	16.5
France	345	202
Germany	618	228
Greece	7	2.66
Hungary	37	7.49
Iceland	8	1.5
Ireland	20	20.4
Italy	54	58.2
Jersey	3	1.64
Luxembourg	115	24
Netherlands	181	146
Norway	212	44.9
Poland	14	5.8
Portugal	11	6.31
Serbia	2	2.35
Slovakia	7	1.34
Spain	116	69.2
Sweden	483	60
Switzerland	63	12.2
Ukraine	2	1.65
United Kingdom	100	86.4
United States	358	146
Others	18	4.173
Total	2,945	1,220

The highest number of green bonds was issued in Germany, Sweden and the US and the largest amount was issued in Germany, France, the Netherlands and the US. The smallest number of green bonds was issued in Serbia, Ukraine, Jersey and the Czech Republic and the lowest amount was issued in Slovakia, Iceland and the Czech Republic. This could be, because Central European countries and the US pay a lot of attention to sustainability and green innovation and more resources are available for this, while Eastern European countries prefer to use their funds for economic growth and therefore have slightly less left over for protecting the environment.

The same selection process as used for the green bonds is followed for the conventional bonds. The only selection criterion that changes, is that the proceeds are not spent on achieving green goals. The number of European conventional bonds remaining after the sample selection process is 3,483 bonds and the number of US conventional bonds is 4,667.

I also use Bloomberg's Fixed Income database to obtain data on the characteristics of the green and conventional bonds, such as coupon rate, bond size and duration. These characteristics are only used for the descriptive statistics, but not in the regressions. This is the case, because these characteristics are not available for all companies that do not issue green bonds, which would result in a low number of observations in the regressions. In addition, I use Standard & Poor's CompuStat North America database to get data from the financial statements about the US firms and Standard & Poor's CompuStat Global database to obtain financial data on the European firms, such as firm size, capital expenditures and interest expenses. The financial data are used in the regressions, because it is available for almost all companies.

The financial data of the US companies are then merged with the bond data of both the green and conventional bonds based on the Ticker of the companies and the data of the European companies are merged based on the equity ISIN (first the bond ISIN had to be linked to the equity ISIN), resulting in one dataset with all the necessary characteristics of the bonds and the issuing firms. In this dataset, the companies that have issued green bonds are the treatment group and all other companies are the control group.

3.2 Descriptive statistics

Table 5 shows the descriptive statistics of the variables used in the regressions for the green bond issuing firms and table 6 for the firms that do not issue green bonds. The tables contain the number of observations, the mean, standard deviation, minimum and maximum.

To reduce the influence of outliers, all financial data are winsorized at the 1st and 99th percentiles of their empirical distribution, just as Flammer (2021) did in her study. Thus, the

dependent variables (panel A) and the issuing firm characteristics (panel C) are winsorized.

There are 61,515 companies in the sample, of which 201 are green bond issuing companies and 61,314 are other companies. For most companies, data are available for the eight fiscal years of the sample period, which runs from January 1, 2015 to December 31, 2022.

The number of observations differs per variable, because certain information is not available for every company. For example, the number of observations of Tobin's Q and ROE is lower than that of ROA and ROS, because the market value of the equity is only available for the North American companies and not for the other companies. In addition, the number of observations of the bond characteristics (panel B) is lower than that of the financial data, because only companies that have issued green or conventional bonds have data available for the bond characteristics. However, this is not an issue, because these characteristics are only used for the descriptive statistics, but not in the regressions.

Table 5 Descriptive statistics of the variables used in the regressions for the green bond issuing firms

Panel A: Dependent variables					
Variable	**Observations**	**Mean**	**Std. Dev.**	**Minimum**	**Maximum**
Tobin's Q	591	1.711	1.348	0.730	19.453
ROE	503	0.032	0.106	-1.328	0.587
ROA	1,404	0.021	0.109	-3.473	0.312
ROS	931	-0.034	3.268	-57.500	0.635
Cost of total debt	601	0.040	0.033	0.000	0.627
Panel B: Bond characteristics					
Bond size (in millions)	1,573	535.000	398.000	3.471	2,500.000
Coupon rate	1,565	2.821	2.259	0.000	13.000
Bond maturity	1,541	5.856	8.242	-1.689	57.585
Bond duration	1,549	3.838	3.541	0.000	16.437
Bond convexity	1,549	0.336	0.707	0.000	3.590
ESG score percentile	968	81.073	20.950	0.000	100.000
Yield spread (in basis points)	1,393	242.686	1,554.903	-3,841.904	39,094.930
CDS spread (in basis points)	1,534	141.123	102.639	8.534	535.016
Panel C: Issuing firm characteristics					
Firm size (logarithm)	1,568	10.392	2.095	0.730	15.229
Employees (in thousands)	1,508	24.330	31.864	0.002	93.087
R&D intensity	462	0.023	0.058	0.000	0.970
Interest coverage	1,418	3.616	46.328	-1,163.000	330.200
Operating cash flow ratio	814	0.453	0.551	-2.874	3.058
Asset turnover	1,568	0.298	0.351	0.000	2.502
Leverage	1,568	5.175	6.056	-8.928	22.183
Corporate investment	928	0.054	0.051	0.000	0.317
Sales growth	764	14.055	50.196	-87.359	683.410

The means of the Firm performance measures are quite close to zero or even negative for both green bond issuing firms and other firms (except Tobin's Q), which may indicate that the average company in the sample has a low firm value and profitability. The means of ROE, ROA and ROS are slightly higher for green bond issuing companies than for other companies, but Tobin's Q is much higher for the other companies than for the green bond issuing ones, namely 7.223 for other companies and 1.711 for green bond issuing ones. The Cost of total debt is somewhat the same for green bond issuing and other companies and is quite low. It is notable that the means of Bond duration, CDS spread, Research and development (R&D) intensity and Corporate investment are almost the same for the two groups. On the other hand, the values of Coupon rate, Bond maturity, Employees, Interest coverage and Leverage differ greatly between green bond issuing and other firms. In general, the bonds have a fairly large amount issued and a relatively short maturity. Green bonds have a lower coupon rate and a longer maturity than conventional bonds. The average ESG score of both groups of companies is quite high, namely in the top quarter of the percentile. The companies in the sample are therefore already heavily involved in sustainability. However, the ESG score of green bond issuing companies is slightly higher than that of other companies. It can be seen that the ranges of possible values of Yield spread, CDS spread and Bond size are very large. They can have very negative or small but also very positive values. The average firm in the sample is quite large, but green bond issuing companies are on average slightly larger than other companies based on the Firm size and Employees. It is striking that the means of the Interest coverage of the companies differ so much from each other. The green bond issuing firms have a relatively small value (3.616) and the other firms a high positive value (44.426). It could be that green bond issuing companies have more debt and can pay it back less easily than other companies, although it may be because the range of values is very large, which results in a different mean. Green bond issuing companies have a higher Leverage (5.175) than other companies (1.673). This may be, because green bond issuing companies have more debt than other companies or less equity. Perhaps they need more debt to finance their green projects and goals. In addition, the Sales growth of the other firms is very high, while that of green bond issuing companies is somewhat lower. Perhaps the innovative projects of the green bond issuing company fail and do not contribute to making the company more sustainable in an efficient manner, which does not result in higher sales.

Table 6 Descriptive statistics of the variables used in the regressions for the firms that do not issue green bonds

Panel A: Dependent variables					
Variable	**Observations**	**Mean**	**Std. Dev.**	**Minimum**	**Maximum**
Tobin's Q	55,618	7.223	31.201	0.373	271.387
ROE	52,522	-0.277	1.070	-8.092	0.587
ROA	333,001	-0.080	0.457	-3.473	0.312
ROS	292,455	-1.042	6.644	-57.500	0.635
Cost of total debt	244,534	0.088	0.191	0.000	1.576
Panel B: Bond characteristics					
Bond size (in millions)	4,457	690.000	465.000	0.319	3,750.000
Coupon rate	4,457	4.165	1.622	0.250	10.500
Bond maturity	4,457	3.585	2.147	0.140	24.460
Bond duration	4,457	3.152	1.665	0.013	7.551
Bond convexity	4,457	0.143	0.130	0.000	0.647
ESG score percentile	4,457	76.422	21.787	1.900	100.000
Yield spread (in basis points)	4,457	205.179	542.311	-7,691.948	4,686.628
CDS spread (in basis points)	4,457	127.839	123.499	20.193	912.596
Panel C: Issuing firm characteristics					
Firm size (logarithm)	371,162	7.303	3.340	-0.989	15.788
Employees (in thousands)	237,549	4.449	12.626	0.001	93.087
R&D intensity	142,544	0.064	0.141	0.000	0.970
Interest coverage	317,510	44.426	346.448	-1,163.000	2,542.944
Operating cash flow ratio	302,510	-0.071	1.539	-8.936	3.200
Asset turnover	370,309	0.680	0.675	0.000	3.580
Leverage	371,209	1.673	3.686	-8.928	22.183
Corporate investment	292,857	0.043	0.056	0.000	0.317
Sales growth	246,559	20.952	89.496	-99.765	683.410

Table 7 shows the correlations between the main variables used in the regressions.

Table 7 Correlation matrix of the main variables used in the regressions

	Green bond firms	**Tobin's Q**	**ROE**	**ROA**	**ROS**	**Cost total debt**	**Firm size (log)**	**Leverage**	**R&D intensity**	**Interest coverage**	**Operating cash flow ratio**	**Sales growth**
Green bond firms	1.000											
Tobin's Q	-0.010	1.000										
ROE	0.026	-0.061	1.000									
ROA	0.037	-0.475	0.442	1.000								
ROS	0.019	-0.243	0.144	0.450	1.000							
Cost total debt	-0.024	0.140	-0.183	-0.321	-0.151	1.000						
Firm size (logarithm)	0.124	-0.282	0.266	0.578	0.306	-0.301	1.000					
Leverage	0.035	-0.068	0.042	0.119	0.068	-0.065	0.159	1.000				
R&D intensity	-0.031	0.307	-0.206	-0.622	-0.429	0.192	-0.432	-0.094	1.000			
Interest coverage	0.010	-0.041	0.071	0.169	0.200	0.008	0.149	0.014	-0.172	1.000		
Operating CF ratio	0.042	-0.055	0.214	0.431	0.482	-0.214	0.401	0.048	-0.460	0.323	1.000	
Sales growth	-0.005	0.056	-0.014	-0.097	-0.015	0.065	-0.118	-0.008	0.119	-0.069	-0.171	1.000

Most correlations are not very strong. There is no or a very weak correlation between green bond issuing firms and the Firm performance and Future cost of debt capital variables. The strongest is between green bond issuing firms and ROA (0.037), which would mean that green bond issuing companies are more profitable than other companies. However, the correlation is very weak and correlation is not causation, so this could be different in the regression analysis. The strongest correlation is between ROA and R&D intensity, namely -0.622. It could be the case that profitable companies invest little in R&D, because they are already fully developed and innovation costs more money than it generates, so they are very profitable without researching and innovating. On the other hand, it could also be the case that companies overinvest in R&D, while they would have generated more profit if they had invested these funds in other projects or investments, so this does not benefit the financial performance of the companies. There is also a negative correlation between R&D intensity and the other Firm performance variables, except Tobin's Q. The correlation between ROA and Firm size is

also quite strong (0.578), which may be because large companies are better known to customers and have many assets, which they use efficiently to generate sales and have lower costs due to economies of scale, which increases the profitability of the firm. There is also a positive correlation between Firm size and the other Firm performance variables, except Tobin's Q. The correlation between ROS and ROA is fairly high (0.450), which is not surprising, because they are both measures of Long-term financial performance. The correlation between Tobin's Q and ROA is also quite strong (-0.475), but the fact that there is a negative correlation between them is surprising, because a positive one would be expected. It would now be the case that companies that experience an increase in their market value in the short term, are less profitable in the long term. There is a negative correlation between ROA and Cost of total debt (-0.321), which may be the case because companies that generate a lot of profit, are more stable and can more easily repay their debts, thus they have a lower cost of debt capital. There is also a negative correlation between Firm size and Cost of total debt (-0.301), which may be the case because large companies have many assets that can serve as collateral, which means that these companies are considered safer and thus have a lower cost of debt capital.

4 Methodology

4.1 Hypothesis 1

To test the hypotheses, the DiD method is used, just as Flammer (2021), Zhou and Cui (2019) and Khurram et al. (2023) did in their studies. This research examines the effect of issuing green bonds on firm performance and the future cost of debt capital, but in order to properly investigate this, it is not possible to consider only green bond issuing companies (treatment group). In addition, companies that do not issue green bonds (control group) should also be considered, as it may be the case that these two groups were different from the beginning. Hence, the DiD method is used, because it does not compare the outcomes of firm performance and the future cost of debt capital, but the change in the outcomes of the two groups before and after the issuance of green bonds. In this way, heterogeneity and endogeneity are prevented to some extent (Khurram et al., 2023; Zhou and Cui, 2019).

The regression performed to test hypothesis 1 is:

$$\textit{Short-term firm value}_{it} = \beta_0 + \beta_1\ \textit{Issued green bonds}_{ijt} + \beta_2\ \textit{Issuing firm characteristics}_{it} + \textit{Industry}_{it} + \textit{Country}_{it} + \textit{Year}_{it} + \varepsilon_{ijt}$$

I use Tobin's Q and ROE as measures of Short-term firm (market) value, because the issuance of green bonds often generates (media) attention and is noticed by (equity) investors, which instantaneously leads to a stock market reaction and causes the market value of the equity to rise or fall, which is visible in these stock-based measures in the short term (Flammer, 2021; Baulkaran, 2019). Tobin's Q is defined as the sum of the book value of the liabilities and the market value of the equity, which is defined as the share price at the end of the fiscal year multiplied by the total number of outstanding shares at the end of the fiscal year, divided by the book value of the equity and the liabilities, and ROE as net income divided by the market value of the equity. Issued green bonds is a dummy variable, which is 1 for the year in which the company issues a green bond and the subsequent years and therefore belongs to the treatment group and is 0 if the company has not issued green bonds and belongs to the control group, so it captures the treatment effect. The subscripts i, j and t represent bond j of company i in year t. ε is the error term. Robust standard errors are included in all regressions to control for heteroskedasticity. If these are not included in the regressions, the tests and levels of significance may be incorrect, meaning that no reliable conclusion can be drawn from the results.

There are variables that influence the relationship between green bond issuance and firm performance and if these are not added to the regression, this could lead to omitted variable bias. The issuing firm characteristics that are therefore used as control variables in the regressions are: Firm size, which is defined as the logarithm of the book value of the assets

of the firm and the number of employees in thousands. R&D intensity is defined as the R&D expenses of the firm divided by the book value of the assets. Interest coverage ratio is defined as the earnings before interest and taxes (EBIT) divided by the interest expenses of the company. Operating cash flow ratio is defined as the operating cash flow divided by the book value of the current liabilities of the firm. Asset turnover is defined as the revenue of the company divided by the book value of the assets. Leverage is defined as the book value of total liabilities divided by the book value of the equity. Corporate investment is defined as the capital expenditures of the company divided by the book value of the assets. Sales growth is defined as the current year's sales minus the previous year's sales, which is then divided by the previous year's sales multiplied by 100. In the regression of hypothesis 1, ROA is also used as a control variable to control for long-term financial performance. To reduce the influence of outliers, all financial data and ratios are winsorized at the 1st and 99th percentiles of their empirical distribution, as described in section 3.2.

The first regression performed for hypothesis 1 is an OLS regression without fixed effects. However, an endogeneity problem may arise, because there may be (unobserved) omitted variables that are fixed over time, but differ across groups or they do not differ across groups, but change over time (Bannier et al., 2022). One way to tackle this is to add industry, country and year fixed effects to the regression. So the second regression includes these fixed effects, which absorb (unobservable) variables that are fixed either across industries and countries or over time. Industry is defined as the four-digit Standard Industrial Classification (SIC) code and country as the country of incorporation of the company. In addition, a third regression is performed that includes firm and year fixed effects, which absorb (unobservable) variables that are fixed either across firms or over time.

4.2 Hypothesis 2

The regression performed to test hypothesis 2 is:

$$\textit{Long-term financial performance}_{it} = \beta_0 + \beta_1\ \textit{Issued green bonds}_{ijt} + \beta_2\ \textit{Issuing firm characteristics}_{it} + \textit{Industry}_{it} + \textit{Country}_{it} + \textit{Year}_{it} + \varepsilon_{ijt}$$

I use ROA and ROS as measures of Long-term financial performance, because it may take some time before the funds obtained from the issuance of the green bonds are deployed and lead to green innovation, sustainable technologies and cost reductions, and are ultimately converted into higher profits in the future, which is visible in these financial ratios in the long term (Khurram et al., 2023; Zhou and Cui, 2019). ROA is defined as net income divided by the book value of the total assets, and ROS as operating profit divided by net sales. Issued green bonds is the same as described above.

The control variables are almost the same as in the previous regression, except that in the regression of hypothesis 2, ROA is not used as a control variable, but Tobin's Q is used to control for short-term firm value.

The first regression performed for hypothesis 2 is an OLS regression without fixed effects. The second regression includes industry, country and year fixed effects and the third regression includes firm and year fixed effects.

4.3 Hypothesis 3

The regression performed to test hypothesis 3 is:

$$Future\ cost\ of\ debt\ capital_{it+1} = \beta_0 + \beta_1\ Issued\ green\ bonds_{ijt} + \beta_2\ Issuing\ firm\ characteristics_{it} + Industry_{it} + Country_{it} + Year_{it} + \varepsilon_{ijt}$$

I use Cost of total debt as a measure of Future cost of debt capital, which is defined as the total interest expenses on debt divided by the book value of the short- and long-term debt of the firm. This measure of the cost of debt capital is also used in the research of Gigante and Manglaviti (2022). Issued green bonds is the same as described above.

In the regression of hypothesis 3, the effect of green bond issuance on the cost of debt capital in the future, not in the present, is examined. Firstly, it must be determined which model best fits the data and variables, so DiD regressions without fixed effects, with industry, country and year fixed effects and with firm and year fixed effects are performed. The best-fitting model is then used to perform separate DiD regressions, where the dependent variable (Cost of total debt) is forwarded one, two, three, four and five periods. This means that the first, second, third, fourth and fifth leads of the Cost of total debt instead of the contemporary ones are included in separate regressions to examine whether issuing green bonds has an effect on the cost of debt capital in the long run.

The control variables are almost the same as in the regression of hypothesis 1, except that in the regression of hypothesis 3, both ROA and Tobin's Q are used as control variables to control for short- and long-term firm performance.

4.4 Robustness checks

There is a possibility that an endogeneity problem may arise. This research already uses the DiD method and fixed effects to limit this issue as much as possible, but this can still occur, for example in the form of simultaneous equations bias. It could be the case, that firms that already have good financial performance or a high firm value, are more likely to issue green bonds, making the relationship actually the opposite of what this study examines, which can influence

the results.

One way to tackle this is to lead the dependent variables in the regressions of hypotheses 1 and 2. Firstly, it must be determined which model best fits the data and variables, so DiD regressions without fixed effects, with industry, country and year fixed effects and with firm and year fixed effects are performed for the short-term firm value and long-term financial performance variables. The best-fitting model is then used to perform separate DiD regressions, where the dependent variables (Tobin's Q, ROE, ROA and ROS) are forwarded one, two and three periods. This means that the first, second and third leads of the dependent variables instead of the contemporary ones are included in separate regressions to examine whether the results are robust and change over time.

In addition, to examine whether the results are robust, the robust standard errors are replaced by clustered standard errors at the firm level. These are used for the regressions with both the short- and long-term firm performance and future cost of debt capital variables, because fixed effects regressions may have regression errors that are heteroskedastic and autocorrelated. The robust standard errors are then not accurate. Clustered standard errors divide observations into smaller groups, where regression errors are allowed to be correlated within the groups, but not across the groups. This ensures that the standard errors of the regressions, and consequently the tests and significance levels, are valid, allowing reliable conclusions to be drawn from the results.

5 Results

5.1 The effect of green bond issuance on short-term firm value

5.1.1 Short-term firm value

Firstly, hypothesis 1 is tested, which states: *"Green bond issuance has a positive direct effect on short-term firm value."* All the regressions in the following tables contain a constant, but because it is quite unlikely that all variables are 0 at the same time, it is not shown in the tables.

Table 8 shows the results of the regressions of the effect of green bond issuance on short-term firm value. All regressions are performed with the DiD method, where regressions 1 and 4 are OLS regressions without fixed effects, regressions 2 and 5 are with industry, country and year fixed effects and regressions 3 and 6 are with firm and year fixed effects, as described in section 4.1.

In table 8, it can be seen that there is a positive relationship between green bond issuance and Tobin's Q (regression 1), which is statistically significant at the 1% level with a p-value of 0.000. The coefficient is 1.852, which means that the Tobin's Q of green bond issuing companies is 1.852 higher than the Tobin's Q of other companies compared to before the bond issuance. The positive relationship between green bond issuance and Tobin's Q is even stronger when the industry, country and year fixed effects are added to the regression (regression 2). The coefficient is 2.097, which means that the Tobin's Q of green bond issuing companies is 2.097 higher than the Tobin's Q of other companies within industries and countries over time compared to before the bond issuance, and this relationship is statistically significant at the 1% level with a p-value of 0.001. The positive relationship is less strong and significant when the firm and year fixed effects are used in the regression (regression 3). However, the relationship between green bond issuance and Tobin's Q is still statistically significant at the 10% level with a p-value of 0.055. The coefficient is 1.044, which means that the Tobin's Q of green bond issuing companies is 1.044 higher than the Tobin's Q of other companies within firms over time compared to before the bond issuance.

In table 8, it can also be seen that there is a positive relationship between green bond issuance and ROE (regression 4), which is statistically significant at the 5% level with a p-value of 0.028. The coefficient is 0.040, which means that the ROE of green bond issuing companies is 0.040 higher than the ROE of other companies compared to before the bond issuance. The positive relationship between green bond issuance and ROE is even stronger when the industry, country and year fixed effects are added to the regression (regression 5). The coefficient is 0.077, which means that the ROE of green bond issuing companies is 0.077 higher than the ROE of other companies within industries and countries over time compared to before the bond issuance, and this relationship is statistically significant at the 5% level with a p-value of 0.018. The positive relationship is even stronger and more significant when the

firm and year fixed effects are used in the regression (regression 6). The relationship is statistically significant at the 1% level with a p-value of 0.000 and the coefficient is 0.102, which means that the ROE of green bond issuing companies is 0.102 higher than the ROE of other companies within firms over time compared to before the bond issuance.

Table 8 Regressions of green bond issuance on short-term firm value

Variable	**Tobin's Q**	**Tobin's Q**	**Tobin's Q**	**ROE**	**ROE**	**ROE**
Regression	(1)	(2)	(3)	(4)	(5)	(6)
Issued green bonds	1.852***	2.097***	1.044*	0.040**	0.077**	0.102***
	(0.488)	(0.657)	(0.543)	(0.018)	(0.033)	(0.027)
Firm size	-0.712***	-0.848***	-1.615***	-0.010**	-0.012**	-0.011
	(0.124)	(0.155)	(0.496)	(0.005)	(0.006)	(0.031)
Employees	0.051***	0.062***	0.061***	0.002***	0.003***	0.004
	(0.007)	(0.009)	(0.017)	(0.000)	(0.000)	(0.002)
R&D intensity	3.283	4.614	8.468	0.616***	0.723***	0.863***
	(3.029)	(3.498)	(5.156)	(0.103)	(0.122)	(0.186)
Interest coverage	0.000	0.000	0.000	0.000*	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)
Operating cash flow	2.493***	2.362***	0.821***	0.035***	0.028***	0.011
ratio	(0.232)	(0.235)	(0.186)	(0.008)	(0.008)	(0.012)
Asset turnover	0.119	0.167	1.660	-0.042***	-0.062***	-0.110**
	(0.417)	(0.659)	(1.339)	(0.016)	(0.024)	(0.050)
Leverage	-0.029	-0.028	0.004	-0.002	-0.002	-0.001
	(0.023)	(0.024)	(0.016)	(0.002)	(0.002)	(0.003)
Corporate investment	-4.104	-3.719	-8.904	0.566**	0.745**	0.967**
	(6.102)	(6.756)	(10.534)	(0.250)	(0.292)	(0.421)
Sales growth	0.003	0.003	0.001	0.000***	0.000***	0.000**
	(0.003)	(0.003)	(0.002)	(0.000)	(0.000)	(0.000)
ROA	-13.219***	-12.579***	-5.190***	0.785***	0.794***	1.016***
	(1.198)	(1.187)	(1.302)	(0.045)	(0.046)	(0.062)
Industry fixed effects	No	Yes	No	No	Yes	No
Country fixed effects	No	Yes	No	No	Yes	No
Year fixed effects	No	Yes	Yes	No	Yes	Yes
Firm fixed effects	No	No	Yes	No	No	Yes
Observations	14,620	14,606	14,020	14,620	14,606	14,020
R^2	0.250	0.276	0.604	0.230	0.253	0.501

The robust standard errors are shown in parentheses. ∗, ∗∗, ∗∗∗ represent significance at the 10%, 5% and 1% levels, respectively.

From these results, it can therefore be deduced with some degree of certainty that green bond issuing companies have a better short-term firm value compared to other companies. However, robustness checks still need to be conducted to investigate whether this positive relationship holds, so that it can be concluded with more certainty that hypothesis 1 cannot be rejected (table 9).

It is notable that regressions 1 to 5 show that there is a negative relationship between Firm size and both Tobin's Q and ROE, while a positive relationship is expected. Theory often shows that large companies are better known to customers and have many assets, which they use efficiently to generate sales and they have lower costs due to economies of scale, which gives them a competitive advantage and therefore leads to a higher firm value. This research shows that larger companies have a Tobin's Q that is 0.712 (regression 1), 0.848 (regression 2) or 1.615 (regression 3) lower and an ROE that is 0.010 (regression 4) or 0.012 (regression 5) lower than smaller companies and this effect is statistically significant at a 1% and 5% level, respectively. This effect could be, because larger companies can have abundant cash, but little positive NPV investments to spend it on, causing (the revenue of) the company to stop growing and the shareholder value to decrease.

Regressions 1 to 5 also show that there is a positive relationship between Employees and both Tobin's Q and ROE. This research shows that companies with many employees have a Tobin's Q that is 0.051 (regression 1), 0.062 (regression 2) or 0.061 (regression 3) higher and an ROE that is 0.002 (regression 4) or 0.003 (regression 5) higher than companies with few employees and this effect is statistically significant at a 1% level. This could be the case, because talented and productive employees can give the company a competitive advantage and lead to higher sales, thus increasing the company's firm value.

There is a positive relationship between R&D intensity and ROE, which was to be expected. This research shows that companies with a high R&D intensity have an ROE that is 0.616 (regression 4), 0.723 (regression 5) or 0.863 (regression 6) higher than companies with a low R&D intensity and this effect is statistically significant at a 1% level. This may be, because companies that have high R&D costs, also have high innovation and technological development, which leads to cost reductions and higher sales as they continue to introduce new products to customers, so the value for shareholders increases.

Regressions 1 to 5 show a positive relationship between Operating cash flow ratio and both Tobin's Q and ROE, which was to be expected. This research shows that companies with a high operating cash flow ratio have a Tobin's Q that is 2.493 (regression 1), 2.362 (regression 2) or 0.821 (regression 3) higher and an ROE that is 0.035 (regression 4) or 0.028 (regression 5) higher than companies with a low operating cash flow ratio and this effect is statistically significant at a 1% level. This could be the case, because companies with a higher operating cash flow ratio generate enough cash to easily pay off their short-term debt, which makes the

company more stable and therefore provides it with a better firm value.

There is a negative relationship between Asset turnover and ROE, while a positive relationship is expected. Theory often shows that companies with a high asset turnover use their assets efficiently, which generates a lot of sales, allowing them to continue to grow and increase their firm value. This research shows that companies with a high asset turnover have an ROE that is 0.042 (regression 4), 0.062 (regression 5) or 0.110 (regression 6) lower than companies with a low asset turnover and this effect is statistically significant at a 1% and 5% level, respectively. It could be the case that companies are misdirecting their assets, which means that they are not generating as much profit as they would have if they had invested them in other projects, thus reducing the shareholder value.

There is a positive relationship between Corporate investment and ROE, which was to be expected. This research shows that companies with a high corporate investment have an ROE that is 0.566 (regression 4), 0.745 (regression 5) or 0.967 (regression 6) higher than companies with a low corporate investment and this effect is statistically significant at a 5% level. This may be the case, because the expenditures that companies make to acquire physical assets, are necessary for an efficient production process or service delivery, making customers more satisfied and loyal to the company, which improves the profitability and firm value.

Regressions 4 to 6 show that there is a positive relationship between ROA and ROE, which was to be expected. This research shows that companies with a high ROA have an ROE that is 0.785 (regression 4), 0.794 (regression 5) or 1.016 (regression 6) higher than companies with a low ROA and this effect is statistically significant at a 1% level. This may be, because when companies invest in long-term projects that achieve high returns or lead to technological development, this increases the profitability, which can also increase the firm value. However, this research also shows that companies with a high ROA have a Tobin's Q that is 13.219 (regression 1), 12.579 (regression 2) or 5.190 (regression 3) lower than companies with a low ROA and this effect is statistically significant at a 1% level. This could be the case, because profitable companies generate a lot of net income, but can also have high liabilities and interest costs, which means that the firm value is lower.

Table 8 also shows the adjusted R^2 of the regressions. The R^2 of the regressions with firm and year fixed effects are quite high, namely 0.604 for regression 3 with Tobin's Q and 0.501 for regression 6 with ROE, which means that the input variables can explain 60.4% and 50.1% of the dependent variables (Tobin's Q and ROE) and the model fits the data quite well.

5.1.2 Robustness checks

To examine whether the results of section 5.1.1 are robust and change over time, the best-fitting model from table 8 is forwarded one, two and three periods. So the first (regressions 1 and 4), second (regressions 2 and 5) and third leads (regressions 3 and 6) of Tobin's Q and ROE instead of the contemporary ones are included in separate regressions, as described in section 4.4. Table 9 shows the results of the regressions of the effect of green bond issuance on the first, second and third lead of short-term firm value.

For Tobin's Q, the best-fitting model is the DiD method with industry, country and year fixed effects, because this relationship between green bond issuance and Tobin's Q is more significant (1% level) than the other models (10% level) and the effect (2.097) is almost twice as strong (1.044). Even though the R^2 is lower (0.276) than that of the model with firm and year fixed effects (0.604), this model is still chosen.

In table 9, it can be seen that there is a positive relationship between green bond issuance and Tobin's Q of next year (regression 1), which is statistically significant at the 1% level with a p-value of 0.001. The coefficient is 2.507, which means that the Tobin's Q of next year of green bond issuing companies is 2.507 higher than the Tobin's Q of next year of other companies within industries and countries over time compared to before the bond issuance. The positive relationship between green bond issuance and Tobin's Q two years into the future is even stronger (regression 2). The coefficient is 2.866, which means that the Tobin's Q two years into the future of green bond issuing companies is 2.866 higher than the Tobin's Q two years into the future of other companies compared to before the bond issuance, and this relationship is statistically significant at the 1% level with a p-value of 0.005. The coefficient of the positive relationship between green bond issuance and Tobin's Q three years into the future is even higher (regression 3). The coefficient is 5.346, which means that the Tobin's Q three years into the future of green bond issuing companies is 5.346 higher than the Tobin's Q three years into the future of other companies compared to before the bond issuance, and this relationship is statistically significant at the 1% level with a p-value of 0.000. The effect of issuing green bonds on Tobin's Q is therefore even greater in the long term, namely the effect increases from an increase in Tobin's Q of green bond issuing companies compared to other companies in the present of 2.097 to an increase in Tobin's Q three years into the future of 5.346.

Table 9 Regressions of green bond issuance on the first, second and third lead of short-term firm value

Variable	**Tobin's Q**	**Tobin's Q**	**Tobin's Q**	**ROE**	**ROE**	**ROE**
	1 year forward	2 years forward	3 years forward	1 year forward	2 years forward	3 years forward
Regression	(1)	(2)	(3)	(4)	(5)	(6)
Issued green bonds	2.507***	2.866***	5.346***	0.088**	0.134**	0.173**
	(0.774)	(1.030)	(1.443)	(0.045)	(0.054)	(0.078)
Firm size	-0.979***	-1.210***	-1.211***	-0.134***	-0.082**	0.015
	(0.182)	(0.227)	(0.270)	(0.028)	(0.039)	(0.052)
Employees	0.069***	0.079***	0.077***	0.002	0.001	0.004
	(0.010)	(0.013)	(0.015)	(0.003)	(0.003)	(0.003)
R&D intensity	2.227	-4.914	-7.680	-0.047	-0.304	-0.190
	(3.660)	(3.956)	(4.946)	(0.174)	(0.205)	(0.313)
Interest coverage	0.000	0.001**	0.001	0.000	0.000	0.000*
	(0.001)	(0.000)	(0.001)	(0.000)	(0.000)	(0.000)
Operating cash flow	2.372***	2.240***	2.252***	0.035**	0.032*	-0.012
ratio	(0.277)	(0.309)	(0.387)	(0.015)	(0.018)	(0.027)
Asset turnover	-0.450	-0.836	0.397	0.072	0.018	0.021
	(0.726)	(0.737)	(1.063)	(0.044)	(0.052)	(0.072)
Leverage	-0.078***	-0.061***	-0.046	-0.002	-0.004	0.006
	(0.020)	(0.0215)	(0.039)	(0.003)	(0.003)	(0.004)
Corporate investment	-5.200	-3.279	-11.523	-0.881**	-0.821*	-0.158
	(7.977)	(8.091)	(7.263)	(0.433)	(0.425)	(0.500)
Sales growth	0.002	0.001	0.004	0.000	0.000	0.000
	(0.002)	(0.003)	(0.004)	(0.000)	(0.000)	(0.000)
ROA	-13.020***	-11.531***	-11.353***	-0.061	-0.312***	-0.090
	(1.352)	(1.391)	(1.805)	(0.058)	(0.079)	(0.089)
Industry fixed effects	Yes	Yes	Yes	No	No	No
Country fixed effects	Yes	Yes	Yes	No	No	No
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	No	No	No	Yes	Yes	Yes
Observations	11,895	9,219	6,882	11,318	8,704	6,477
R^2	0.256	0.211	0.167	0.382	0.385	0.333

The robust standard errors are shown in parentheses. *, **, *** represent significance at the 10%, 5% and 1% levels, respectively.

For ROE, the best-fitting model is the DiD method with firm and year fixed effects, because this relationship between green bond issuance and ROE is more significant (1% level) than the other models (5% level) and the effect (0.102) is stronger (0.077). In addition, the R^2 is

almost twice as large (0.501) as that of the model with industry, country and year fixed effects (0.253).

In table 9, it can also be seen that there is a positive relationship between green bond issuance and ROE of next year (regression 4), which is statistically significant at the 5% level with a p-value of 0.048. The coefficient is 0.088, which means that the ROE of next year of green bond issuing companies is 0.088 higher than the ROE of next year of other companies within firms over time compared to before the bond issuance. The positive relationship between green bond issuance and ROE two years into the future is even stronger (regression 5). The coefficient is 0.134, which means that the ROE two years into the future of green bond issuing companies is 0.134 higher than the ROE two years into the future of other companies compared to before the bond issuance, and this relationship is statistically significant at the 5% level with a p-value of 0.013. The coefficient of the positive relationship between green bond issuance and ROE three years into the future is even higher (regression 6). The coefficient is 0.173, which means that the ROE three years into the future of green bond issuing companies is 0.173 higher than the ROE three years into the future of other companies compared to before the bond issuance, and this relationship is statistically significant at the 5% level with a p-value of 0.028. The effect of issuing green bonds on ROE is therefore even greater in the long term, namely the effect increases from an increase in ROE of green bond issuing companies compared to other companies in the present of 0.102 to an increase in ROE three years into the future of 0.173.

Thus, from these results it can be deduced with a considerable degree of certainty that green bond issuance has a positive effect on short-term firm value compared to not issuing green bonds, so hypothesis 1 cannot be rejected. This result is consistent with what Flammer (2021), Tan et al. (2022) and Khurram et al. (2023) found in their studies. The positive effect of green bond issuance on short-term firm value could be explained by the fact that the issuance of green bonds leads to (media) attention, which increases the share price of the firm (Flammer, 2021) and also improves the company's reputation, because the company visibly sends a signal that it is committed to the environment and wants to become more sustainable (Tang and Zhang, 2020; Huang, 2022). In addition, the funds obtained from the green bonds could be spent on positive NPV projects and used for innovation and technological development, which leads to cost reductions and a higher firm value in both the short- and long-term (Yeow and Ng, 2021; Zhou and Cui, 2019; Tan et al., 2022).

To examine whether the previous results are robust, the robust standard errors are replaced by clustered standard errors at the firm level. Table 10 shows the results of the regressions of the effect of green bond issuance on the regular, first, second and third lead of short-term firm value with clustered standard errors at the firm level.

Table 10 Regressions of green bond issuance on the regular, first, second and third lead of short-term firm value with clustered standard errors at the firm level

Variable	**Tobin's Q**	**Tobin's Q**	**Tobin's Q**	**Tobin's Q**	**ROE**	**ROE**	**ROE**	**ROE**
	0 year forward	1 year forward	2 years forward	3 years forward	0 year forward	1 year forward	2 years forward	3 years forward
Regression	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Issued green bonds	2.097**	2.507**	2.866*	5.346***	0.102***	0.088**	0.134***	0.173**
	(1.017)	(1.239)	(1.657)	(1.950)	(0.023)	(0.037)	(0.048)	(0.079)
Industry fixed effects	Yes	Yes	Yes	Yes	No	No	No	No
Country fixed effects	Yes	Yes	Yes	Yes	No	No	No	No
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	No	No	No	No	Yes	Yes	Yes	Yes
Observations	14,606	11,895	9,219	6,882	14,020	11,318	8,704	6,477
R^2	0.276	0.256	0.211	0.167	0.501	0.382	0.385	0.333

The robust standard errors are shown in parentheses. *, **, *** represent significance at the 10%, 5% and 1% levels, respectively.

The value of the coefficients of the positive relationship between green bond issuance and both Tobin's Q and ROE does not change, but the significance of some of the coefficients does. The significance levels of the coefficients of the effect of green bond issuance on Tobin's Q deteriorate slightly, while those of ROE improve slightly. For example, the p-value of the Issued green bonds coefficient of regression 2 increases from 0.001 to 0.043, while that of regression 6 decreases from 0.048 to 0.018. However, the coefficients of all regressions remain strong and significant, so the clustered standard errors do not affect the positive relationship between green bond issuance and short-term firm value. In fact, it gives an indication that the relationship is fairly robust.

5.2 The effect of green bond issuance on long-term financial performance

5.2.1 Long-term financial performance

Secondly, hypothesis 2 is tested, which states: *"Green bond issuance has a positive direct effect on long-term financial performance."*

Table 11 shows the results of the regressions of the effect of green bond issuance on long-term financial performance. All regressions are performed with the DiD method, where regressions 1 and 4 are OLS regressions without fixed effects, regressions 2 and 5 are with industry, country and year fixed effects and regressions 3 and 6 are with firm and year fixed effects, as described in section 4.2.

Table 11 Regressions of green bond issuance on long-term financial performance

Variable	**ROA**	**ROA**	**ROA**	**ROS**	**ROS**	**ROS**
Regression	(1)	(2)	(3)	(4)	(5)	(6)
Issued green bonds	-0.065***	-0.107***	-0.004	-1.030	-1.467	-0.309*
	(0.018)	(0.026)	(0.017)	(1.097)	(1.149)	(0.162)
Firm size	0.098***	0.110***	0.196***	0.373***	0.605***	0.086
	(0.004)	(0.004)	(0.015)	(0.052)	(0.062)	(0.272)
Employees	-0.005***	-0.005***	-0.006***	-0.026***	-0.032***	-0.008
	(0.000)	(0.000)	(0.001)	(0.003)	(0.004)	(0.009)
R&D intensity	-1.186***	-1.339***	-1.486***	-9.802***	-8.810***	-5.293***
	(0.051)	(0.056)	(0.098)	(1.011)	(1.149)	(1.757)
Interest coverage	0.000**	0.000	0.000	0.001***	0.001**	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Operating cash flow	0.049***	0.046***	0.034***	2.307***	1.900***	0.761***
ratio	(0.004)	(0.005)	(0.006)	(0.122)	(0.125)	(0.165)
Asset turnover	0.049***	0.094***	0.069***	2.568***	3.568***	2.794***
	(0.009)	(0.014)	(0.027)	(0.128)	(0.186)	(0.374)
Leverage	0.002***	0.003***	0.001	0.035***	0.034***	0.015
	(0.001)	(0.001)	(0.001)	(0.011)	(0.012)	(0.013)
Corporate	-0.484***	-0.211	-0.410**	-7.515***	-7.017***	-4.017
investment	(0.137)	(0.154)	(0.181)	(2.010)	(2.253)	(2.694)
Sales growth	0.000*	0.000	0.000***	0.009***	0.011***	0.018***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)
Tobin's Q	-0.010***	-0.009***	-0.003***	-0.088***	-0.090***	-0.056***
	(0.001)	(0.001)	(0.001)	(0.013)	(0.013)	(0.014)
Industry fixed effects	No	Yes	No	No	Yes	No
Country fixed effects	No	Yes	No	No	Yes	No
Year fixed effects	No	Yes	Yes	No	Yes	Yes
Firm fixed effects	No	No	Yes	No	No	Yes
Observations	14,620	14,606	14,020	14,486	14,472	13,886
R^2	0.600	0.628	0.819	0.361	0.397	0.744

The robust standard errors are shown in parentheses. ∗, ∗∗, ∗∗∗ represent significance at the 10%, 5% and 1% levels, respectively.

In table 11, it can be seen that there is a negative relationship between green bond issuance and ROA (regression 1), which is statistically significant at the 1% level with a p-value of 0.000. The coefficient is -0.065, which means that the ROA of green bond issuing companies is 0.065 lower than the ROA of other companies compared to before the bond issuance. The negative relationship between green bond issuance and ROA is even more negative when the industry, country and year fixed effects are added to the regression (regression 2). The coefficient is

-0.107, which means that the ROA of green bond issuing companies is 0.107 lower than the ROA of other companies within industries and countries over time compared to before the bond issuance, and this relationship is statistically significant at the 1% level with a p-value of 0.000. The negative relationship between green bond issuance and ROA is no longer significant when the firm and year fixed effects are used in the regression (regression 3). It is not even statistically significant at the 10% level, because the p-value is 0.819.

In table 11, it can also be seen that there is no statistically significant relationship between green bond issuance and ROS when the DiD method without fixed effects is used (regression 4). It is not even statistically significant at the 10% level, because the p-value is 0.348. There is still no statistically significant relationship between green bond issuance and ROS when the industry, country and year fixed effects are added to the regression (regression 5). The p-value is 0.202, so it is not even statistically significant at the 10% level. However, there is a negative relationship between green bond issuance and ROS when the firm and year fixed effects are used in the regression (regression 6). The relationship is statistically significant at the 10% level with a p-value of 0.057 and the coefficient is -0.309, which means that the ROS of green bond issuing companies is 0.309 lower than the ROS of other companies within firms over time compared to before the bond issuance.

The results are inconclusive, so it cannot be deduced with certainty that there is a relationship between green bond issuance and long-term financial performance. There is some weak evidence that there is a negative relationship, but this is only visible in half of the regressions. However, robustness checks still need to be conducted to investigate whether there is a statistically significant relationship, so that it can be concluded with more certainty whether or not hypothesis 2 can be rejected (table 12).

It is notable that regressions 1 to 5 show that there is a positive relationship between Firm size and both ROA and ROS, which was to be expected. This research shows that larger companies have an ROA that is 0.098 (regression 1), 0.110 (regression 2) or 0.196 (regression 3) higher and an ROS that is 0.373 (regression 4) or 0.605 (regression 5) higher than smaller companies and this effect is statistically significant at a 1% level. This effect could be, because large companies have more assets, which they can use in the production process and are better known to customers, which means they have higher sales and therefore higher profitability.

It is noticeable that there is a negative relationship between R&D intensity and both ROA and ROS, while a positive relationship is expected. Theory often shows that high R&D costs lead to innovation, which increases the profitability and performance of companies (Wang et al., 2022). This research shows that companies with a high R&D intensity have an ROA that is 1.186 (regression 1), 1.339 (regression 2) or 1.486 (regression 3) lower and an ROS that is 9.802 (regression 4), 8.810 (regression 5) or 5.293 (regression 6) lower than

companies with a low R&D intensity and this effect is statistically significant at a 1% level. This could be, because companies spend more on R&D than is optimal to achieve the highest level of innovation, so they would have been better off investing these funds in another project, which would generate more profits.

Regressions 1 to 6 show that there is a positive relationship between Operating cash flow ratio and both ROA and ROS, which was to be expected. This research shows that companies with a high operating cash flow ratio have an ROA that is 0.049 (regression 1), 0.046 (regression 2) or 0.034 (regression 3) higher and an ROS that is 2.307 (regression 4), 1.900 (regression 5) or 0.761 (regression 6) higher than companies with a low operating cash flow ratio and this effect is statistically significant at a 1% level. This could be the case, because if the company has more operating cash flow, it means that it generates more profit from its core business, which can be invested in new projects, allowing the company to grow and not having to take out a new loan for this, which is beneficial for the profitability.

There is a positive relationship between Asset turnover and both ROA and ROS. This research shows that companies with a high asset turnover have an ROA that is 0.049 (regression 1), 0.094 (regression 2) or 0.069 (regression 3) higher and an ROS that is 2.568 (regression 4), 3.568 (regression 5) or 2.794 (regression 6) higher than companies with a low asset turnover and this effect is statistically significant at a 1% level. This may be, because companies use their assets effectively and therefore generate a lot of revenue, which can be reinvested, allowing the company to continue to grow and become more profitable.

Regressions 4 and 5 show that there is a positive relationship between Leverage and ROS, while a negative relationship is expected. Theory often shows that companies with high leverage have more debt than equity, which means they have to pay more interest expenses and their credit risk is higher, which has a negative effect on the profitability. This research shows that companies with high leverage have an ROS that is 0.035 (regression 4) or 0.034 (regression 5) higher than companies with low leverage and this effect is statistically significant at a 1% level. This could be the case, because companies are taking on more debt to finance large investments or expansions that otherwise could not have been made, which generate more profits than they cost.

Regressions 1, 3, 4 and 5 show that there is a negative relationship between Corporate investment and both ROA and ROS, while a positive relationship is expected. Theory often shows that the expenditures that companies make to acquire physical assets, contribute to an efficient production process or provision of services, which makes the customers more satisfied and loyal to the company, thereby improving the company's profitability. This research shows that companies with a high corporate investment have an ROA that is 0.484 (regression 1) or 0.410 (regression 3) lower and an ROS that is 7.515 (regression 4) or 7.017 (regression 5) lower than companies with a low corporate investment and this effect is statistically significant

at a 1% and 5% level, respectively. This may be the case, because companies invest in the wrong physical assets, which do not ensure that the companies operate more efficiently and do not provide economies of scale, causing costs to increase instead of decrease and the profitability to decrease.

Regressions 4 to 6 show that there is a negative relationship between Tobin's Q and ROS, while a positive relationship is expected. Theory often shows that companies with a high firm value are less risky and have a stable stream of income, which means that their financial performance is also better. This research shows that companies with a high Tobin's Q have an ROS that is 0.088 (regression 4), 0.090 (regression 5) or 0.056 (regression 6) lower than companies with a low Tobin's Q and this effect is statistically significant at a 1% level. This could be the case, because companies with a high firm value are overvalued in the stock market, while the underlying assets are worth less and the company no longer grows, reducing the profitability.

Table 11 also shows the adjusted R^2 of the regressions. The R^2 of the regressions with firm and year fixed effects are quite high, namely 0.819 for regression 3 with ROA and 0.744 for regression 6 with ROS, which means that the input variables can explain 81.9% and 74.4% of the dependent variables (ROA and ROS) and the model fits the data quite well.

5.2.2 Robustness checks

To examine whether the results of section 5.2.1 are robust and change over time, the best-fitting model from table 11 is forwarded one, two and three periods. So the first (regressions 1 and 4), second (regressions 2 and 5) and third leads (regressions 3 and 6) of ROA and ROS instead of the contemporary ones are included in separate regressions, as described in section 4.4. Table 12 shows the results of the regressions of the effect of green bond issuance on the first, second and third lead of long-term financial performance.

Table 12 Regressions of green bond issuance on the first, second and third lead of long-term financial performance

Variable	**ROA**	**ROA**	**ROA**	**ROS**	**ROS**	**ROS**
	1 year forward	2 years forward	3 years forward	1 year forward	2 years forward	3 years forward
Regression	(1)	(2)	(3)	(4)	(5)	(6)
Issued green bonds	0.010	0.032	0.067***	0.031	0.137	0.104
	(0.020)	(0.023)	(0.025)	(0.107)	(0.126)	(0.139)
Firm size	-0.026	-0.068**	-0.035	0.001	0.313	-0.144
	(0.020)	(0.027)	(0.034)	(0.304)	(0.396)	(0.522)
Employees	0.000	0.002	0.002	-0.002	-0.008	0.010
	(0.001)	(0.001)	(0.001)	(0.009)	(0.011)	(0.013)
R&D intensity	-0.307**	0.104	0.201	1.573	-1.586	0.949
	(0.127)	(0.123)	(0.173)	(2.104)	(2.609)	(2.854)
Interest coverage	0.000**	0.000*	0.000***	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
Operating cash flow	0.020*	-0.002	-0.010	0.368*	0.132	0.300
ratio	(0.011)	(0.011)	(0.014)	(0.198)	(0.206)	(0.246)
Asset turnover	0.084***	0.028	0.011	0.125	-0.076	-0.468
	(0.031)	(0.032)	(0.042)	(0.437)	(0.464)	(0.540)
Leverage	0.000	-0.001	-0.001	0.004	-0.016	-0.004
	(0.001)	(0.001)	(0.001)	(0.015)	(0.015)	(0.020)
Corporate	-0.023	-0.702***	-0.187	-3.063	-5.484**	-3.775
investment	(0.249)	(0.268)	(0.371)	(2.251)	(2.608)	(3.755)
Sales growth	0.000	0.000	0.000	0.004**	0.001	-0.006**
	(0.000)	(0.000)	(0.000)	(0.002)	(0.002)	(0.002)
Tobin's Q	0.000	0.000	0.000	0.002	0.036	0.019
	(0.001)	(0.001)	(0.002)	(0.021)	(0.022)	(0.041)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	11,056	8,585	6,385	10,960	8,506	6,309
R^2	0.742	0.737	0.731	0.698	0.707	0.714

The robust standard errors are shown in parentheses. *, **, *** represent significance at the 10%, 5% and 1% levels, respectively.

For ROA, the best-fitting model is the DiD method with firm and year fixed effects, because this relationship between green bond issuance and ROA has a higher R^2 (0.819) than the model with industry, country and year fixed effects (0.628). Even though the coefficient is less strong and significant than that of the other model, this model is still chosen, because the coefficients of the control variables are more logical and significant.

In table 12, it can be seen that there is no statistically significant relationship between green bond issuance and ROA of next year (regression 1). It is not even statistically significant at the 10% level, because the p-value is 0.620. There is also no statistically significant relationship between green bond issuance and ROA two years into the future (regression 2). The p-value is 0.161, so it is not even statistically significant at the 10% level. However, there is a positive relationship between green bond issuance and ROA three years into the future (regression 3). The coefficient is 0.067, which means that the ROA three years into the future of green bond issuing companies is 0.067 higher than the ROA three years into the future of other companies within firms over time compared to before the bond issuance, and this relationship is statistically significant at the 1% level with a p-value of 0.008. The effect of issuing green bonds on ROA is therefore only visible after three years. Three years after the green bond issuance, the ROA of green bond issuing companies is 0.067 higher than that of other companies.

For ROS, the best-fitting model is the DiD method with firm and year fixed effects, because this relationship between green bond issuance and ROS is statistically significant at the 10% level, while the coefficients of the other models are not significant. In addition, the R^2 is almost twice as large (0.744) as that of the model with industry, country and year fixed effects (0.397).

In table 12, it can also be seen that there is no statistically significant relationship between green bond issuance and ROS of next year (regression 4). It is not even statistically significant at the 10% level, because the p-value is 0.775. There is also no statistically significant relationship between green bond issuance and ROS two years into the future (regression 5). The p-value is 0.276, so it is not even statistically significant at the 10% level. There is also no statistically significant relationship between green bond issuance and ROS three years into the future (regression 6). It is not even statistically significant at the 10% level, because the p-value is 0.453. Thus, there is no relationship between green bond issuance and ROS in future years.

Thus, from these results it can be deduced with some degree of certainty that there is no statistically significant relationship between green bond issuance and long-term financial performance, so hypothesis 2 can be rejected. This result is consistent with what Yeow and Ng (2021) found in their study. The fact that there is no statistically significant relationship between green bond issuance and long-term financial performance could be explained by the fact that companies may have spent the funds obtained through the green bonds on sustainable technology and green innovation, but that these projects have failed and do not contribute to making the company (more) sustainable in an efficient manner (Wang et al., 2022; Khurram et al., 2023). As a result, these green investments do not provide cost reductions or a competitive advantage and therefore do not generate more profits than before (Tan et al.,

2022; Zhou and Cui, 2019). In addition, it could be that green bond issuance only has an effect on the short-term share price and firm value, but that in the long term it does not contribute to (environmental) performance and an improved reputation, so that the long-term profitability and firm performance do not increase (Yeow and Ng, 2021).

To examine whether hypothesis 2 can definitely be rejected, the robust standard errors are replaced by clustered standard errors at the firm level. Table 13 shows the results of the regressions of the effect of green bond issuance on the regular, first, second and third lead of long-term financial performance with clustered standard errors at the firm level.

Table 13 Regressions of green bond issuance on the regular, first, second and third lead of long-term financial performance with clustered standard errors at the firm level

Variable	**ROA**	**ROA**	**ROA**	**ROA**	**ROS**	**ROS**	**ROS**	**ROS**
	0 year forward	1 year forward	2 years forward	3 years forward	0 year forward	1 year forward	2 years forward	3 years forward
Regression	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Issued green bonds	-0.004	0.010	0.032	0.067***	-0.309**	0.031	0.137	0.104
	(0.024)	(0.017)	(0.024)	(0.020)	(0.145)	(0.120)	(0.129)	(0.144)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	14,020	11,056	8,585	6,385	13,886	10,960	8,506	6,309
R^2	0.819	0.742	0.737	0.731	0.744	0.698	0.707	0.714

The robust standard errors are shown in parentheses. ∗, ∗∗, ∗∗∗ represent significance at the 10%, 5% and 1% levels, respectively.

The value of the coefficients of the relationship between green bond issuance and both ROA and ROS does not change, but the significance of some of the coefficients does. The significance levels of the coefficients deteriorate slightly, but many were already not significant before this robustness check. For example, the p-value of the Issued green bonds coefficient of regression 3 increases from 0.161 to 0.195. However, the p-value of the Issued green bonds coefficient of regression 5 decreases from 0.057 to 0.033. However, the coefficients of all regressions are still weak and small, so the clustered standard errors do not change the fact that hypothesis 2 can be rejected.

5.3 The effect of green bond issuance on the future cost of debt capital

5.3.1 Future cost of debt capital

Thirdly, hypothesis 3 is tested, which states: *"Green bond issuance has a negative direct effect on the cost of debt capital of the issuing firm in the future."*

Table 14 shows the results of the regressions of the effect of green bond issuance on the future cost of debt capital. All regressions are performed with the DiD method, where regression 1 is an OLS regression without fixed effects, regression 2 is with industry, country and year fixed effects and regression 3 is with firm and year fixed effects, as described in section 4.3.

In table 14, it can be seen that there is no statistically significant relationship between green bond issuance and Cost of total debt when the DiD method without fixed effects is used (regression 1). It is not even statistically significant at the 10% level, because the p-value is 0.472. However, there is a positive relationship between green bond issuance and Cost of total debt when the industry, country and year fixed effects are added to the regression (regression 2). The coefficient is 0.024, which means that the cost of debt capital of green bond issuing companies is 2.4% of total debt higher than the cost of debt capital of other companies within industries and countries over time compared to before the bond issuance, and this relationship is statistically significant at the 1% level with a p-value of 0.000. The positive relationship is slightly less strong when the firm and year fixed effects are used in the regression (regression 3). However, the coefficient is still 0.020, which means that the cost of debt capital of green bond issuing companies is 2.0% of total debt higher than the cost of debt capital of other companies within firms over time compared to before the bond issuance, and this relationship is statistically significant at the 1% level with a p-value of 0.000.

From these results, it can therefore be deduced with some degree of certainty that green bond issuing companies have a higher cost of debt capital compared to other companies. However, robustness checks still need to be conducted to investigate whether this positive relationship holds, so that it can be concluded with more certainty that hypothesis 3 can be rejected (table 15).

Table 14 Regressions of green bond issuance on the future cost of debt capital

Variable	**Cost of total debt**	**Cost of total debt**	**Cost of total debt**
Regression	(1)	(2)	(3)
Issued green bonds	0.003	0.024***	0.020***
	(0.005)	(0.007)	(0.005)
Firm size	-0.015***	-0.016***	-0.039***
	(0.001)	(0.001)	(0.008)
Employees	0.000***	0.000***	0.001***
	(0.000)	(0.000)	(0.000)
R&D intensity	-0.062***	-0.065**	-0.090**
	(0.024)	(0.028)	(0.045)
Interest coverage	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)
Operating cash flow	-0.013***	-0.013***	-0.004
ratio	(0.003)	(0.003)	(0.005)
Asset turnover	-0.008**	-0.009*	0.011
	(0.003)	(0.005)	(0.012)
Leverage	-0.001	-0.001*	0.000
	(0.000)	(0.000)	(0.000)
Corporate investment	-0.073	-0.088	-0.234***
	(0.049)	(0.057)	(0.087)
Sales growth	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
ROA	-0.077***	-0.074***	-0.013
	(0.009)	(0.009)	(0.013)
Tobin's Q	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
Industry fixed effects	No	Yes	No
Country fixed effects	No	Yes	No
Year fixed effects	No	Yes	Yes
Firm fixed effects	No	No	Yes
Observations	13,934	13,918	13,327
R^2	0.135	0.146	0.345

The robust standard errors are shown in parentheses. *, **, *** represent significance at the 10%, 5% and 1% levels, respectively.

It is notable that regressions 1 to 3 show that there is a negative relationship between Firm size and Cost of total debt, which was to be expected. This research shows that larger companies have a cost of debt capital that is 1.5% (regression 1), 1.6% (regression 2) or 3.9%

(regression 3) of total debt lower than smaller companies and this effect is statistically significant at a 1% level. This is the case, because larger companies with many assets are perceived as safer by investors, because they have a stable stream of income and are less likely to go bankrupt, meaning investors accept a lower cost of debt capital.

Regressions 1 to 3 show that there is a negative relationship between R&D intensity and Cost of total debt, which was to be expected. This research shows that companies with a high R&D intensity have a cost of debt capital that is 6.2% (regression 1), 6.5% (regression 2) or 9.0% (regression 3) of total debt lower than companies with a low R&D intensity and this effect is statistically significant at a 1% and 5% level, respectively. This could be the case, because companies that invest heavily in R&D are often more innovative and technically developed than other companies, which gives them a competitive advantage and improves profitability. This ensures that the company is more stable and secure, causing investors to accept a lower cost of debt capital.

Regressions 1 and 2 show that there is a negative relationship between Operating cash flow ratio and Cost of total debt, which was to be expected. This research shows that companies with a high operating cash flow ratio have a cost of debt capital that is 1.3% (regressions 1 and 2) of total debt lower than companies with a low operating cash flow ratio and this effect is statistically significant at a 1% level. This may be, because companies with a higher operating cash flow ratio generate a lot of cash, allowing them to easily repay their interest costs and short-term debt and they are therefore perceived as less risky, reducing their cost of debt capital.

Regressions 1 and 2 show that there is a negative relationship between Asset turnover and Cost of total debt, which was to be expected. This research shows that companies with a high asset turnover have a cost of debt capital that is 0.8% (regression 1) or 0.9% (regression 2) of total debt lower than companies with a low asset turnover and this effect is statistically significant at a 5% and 10% level, respectively. This could be the case, because companies with a high asset turnover use their assets efficiently, which generates a lot of revenue, which allows them to continue to grow and get a stable income stream, allowing them to easily repay their debts and therefore have a lower cost of debt capital.

Only regression 3 shows that there is a negative relationship between Corporate investment and Cost of total debt, which was to be expected. This research shows that companies with a high corporate investment have a cost of debt capital that is 23.4% of total debt lower than companies with a low corporate investment and this effect is statistically significant at a 1% level. This may be the case, because the expenditures that companies make to acquire physical assets are necessary for the company to function efficiently, which keeps the company profitable and allows the assets to serve as collateral, making it more secure for investors to lend money to the company and therefore they require a lower cost of

debt capital.

Regressions 1 and 2 show that there is a negative relationship between ROA and Cost of total debt, which was to be expected. This research shows that companies with a high ROA have a cost of debt capital that is 7.7% (regression 1) or 7.4% (regression 2) of total debt lower than companies with a low ROA and this effect is statistically significant at a 1% level. This could be the case, because companies with a high ROA are profitable, which means that the companies have more funds to repay their debts and investors therefore accept a lower cost of debt capital.

Table 14 also shows the adjusted R^2 of the regressions. The R^2 of the regression with firm and year fixed effects is higher than that of the regression with industry, country and year fixed effects, namely 0.345 for regression 3 and 0.146 for regression 2, which means that the input variables can explain 34.5% and 14.6% of the dependent variable (Cost of total debt) and the model fits the data.

5.3.2 Robustness checks

To examine whether the results of section 5.3.1 are robust and change over time, the best-fitting model from table 14 is forwarded one, two, three, four and five periods. So the first (regression 1), second (regression 2), third (regression 3), fourth (regression 4) and fifth (regression 5) leads of Cost of total debt instead of the contemporary ones are included in separate regressions, as described in section 4.3. Table 15 shows the results of the regressions of the effect of green bond issuance on the first, second, third, fourth and fifth lead of future cost of debt capital.

Table 15 Regressions of green bond issuance on the first, second, third, fourth and fifth lead of future cost of debt capital

Variable	**Cost of total debt**	**Cost of total debt**	**Cost of total debt**	**Cost of total debt**	**Cost of total debt**
	1 year forward	2 years forward	3 years forward	4 years forward	5 years forward
Regression	(1)	(2)	(3)	(4)	(5)
Issued green bonds	0.010*	0.014***	0.003	0.002	0.010**
	(0.005)	(0.004)	(0.005)	(0.006)	(0.005)
Firm size	-0.036***	0.000	-0.002	0.032*	-0.035
	(0.009)	(0.010)	(0.012)	(0.019)	(0.037)
Employees	0.001***	0.000	0.000	0.000	0.001
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)
R&D intensity	0.041	-0.005	-0.026	0.218*	-0.037
	(0.057)	(0.060)	(0.069)	(0.116)	(0.237)
Interest coverage	0.000***	0.000	0.000	0.000	0.000*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Operating cash flow	0.016***	0.010*	-0.001	-0.013	0.000
ratio	(0.006)	(0.005)	(0.006)	(0.011)	(0.006)
Asset turnover	-0.007	0.002	-0.011	0.002	-0.045
	(0.013)	(0.017)	(0.018)	(0.020)	(0.041)
Leverage	0.000	0.001*	-0.001	-0.001	0.001
	(0.000)	(0.001)	(0.001)	(0.001)	(0.002)
Corporate investment	-0.004	-0.032	-0.096	-0.022	0.236
	(0.099)	(0.103)	(0.120)	(0.136)	(0.210)
Sales growth	0.000	0.000**	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ROA	-0.014	-0.021	-0.024	0.045***	-0.039
	(0.017)	(0.016)	(0.015)	(0.016)	(0.046)
Tobin's Q	0.001	0.000	-0.001*	0.001	-0.003
	(0.000)	(0.000)	(0.000)	(0.001)	(0.002)
Year fixed effects	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	10,365	8,048	6,078	4,188	2,470
R^2	0.353	0.368	0.510	0.500	0.437

The robust standard errors are shown in parentheses. *, **, *** represent significance at the 10%, 5% and 1% levels, respectively.

For Cost of total debt, the best-fitting model is the DiD method with firm and year fixed effects, because this relationship between green bond issuance and Cost of total debt has an R^2 that

is more than twice as large (0.345) as that of the model with industry, country and year fixed effects (0.146). In addition, the coefficient of this model is as significant (1% level) and almost as strong as that of the other model.

In table 15, it can be seen that there is a positive relationship between green bond issuance and Cost of total debt of next year (regression 1), which is statistically significant at the 10% level with a p-value of 0.055. The coefficient is 0.010, which means that the cost of debt capital of next year of green bond issuing companies is 1.0% of total debt higher than the cost of debt capital of next year of other companies within firms over time compared to before the bond issuance. The positive relationship between green bond issuance and Cost of total debt two years into the future is even stronger and more significant (regression 2). The coefficient is 0.014, which means that the cost of debt capital two years into the future of green bond issuing companies is 1.4% of total debt higher than the cost of debt capital two years into the future of other companies compared to before the bond issuance, and this relationship is statistically significant at the 1% level with a p-value of 0.002. There is no statistically significant relationship between green bond issuance and Cost of total debt three years into the future (regression 3). It is not even statistically significant at the 10% level, because the p-value is 0.577. There is still no statistically significant relationship between green bond issuance and Cost of total debt four years into the future (regression 4). The p-value is 0.718, so it is not even statistically significant at the 10% level. However, there is a positive relationship between green bond issuance and Cost of total debt five years into the future (regression 5), which is statistically significant at the 5% level with a p-value of 0.047. The coefficient is 0.010, which means that the cost of debt capital five years into the future of green bond issuing companies is 1.0% of total debt higher than the cost of debt capital five years into the future of other companies compared to before the bond issuance.

The cost of debt capital of green bond issuing companies compared to other companies is 2.0% of total debt higher in the year of issuance, 1.0% of total debt higher one year after issuance, 1.4% of total debt higher two years after issuance, the same as that of other companies three and four years after issuance and 1.0% of total debt higher five years after issuance, so the effect of issuing green bonds on cost of debt capital diminishes slightly as time passes. However, both in the short- and long-term, the cost of debt capital of green bond issuing companies is slightly higher compared to other companies.

Thus, from these results it can be deduced with some degree of certainty that green bond issuance has a positive effect on cost of debt capital of the issuing firm in the future compared to not issuing green bonds, so hypothesis 3 can be rejected. This result is not consistent with the existing literature. Studies such as Zhang et al. (2021) and Hyun et al. (2020), found a negative relationship between green bond issuance and cost of debt capital. The positive relationship between green bond issuance and cost of debt capital of the issuing

firm in the future could be explained by the fact that the company already has a bad reputation and potential bondholders are afraid that the company may be guilty of greenwashing and that it will not use the funds from the green bond in an environmentally friendly manner (Flammer, 2021; Tang and Zhang, 2020). Therefore, the company's reputation does not improve, because investors are not convinced that the company wants to become more sustainable and wants to invest in green development (Zerbib, 2019; Zhang et al., 2021). As a result, the company is actually perceived as riskier by investors, which prevents the company from obtaining a better credit rating, which in turn increases the cost of debt capital in both the short- and long-term (Sun and Cui, 2014; Jiraporn et al., 2014).

To examine whether the previous results are robust, the robust standard errors are replaced by clustered standard errors at the firm level. Table 16 shows the results of the regressions of the effect of green bond issuance on the regular, first, second, third, fourth and fifth lead of future cost of debt capital with clustered standard errors at the firm level.

Table 16 Regressions of green bond issuance on the regular, first, second, third, fourth and fifth lead of future cost of debt capital with clustered standard errors at the firm level

Variable	**Cost of total debt**	**Cost of total debt**	**Cost of total debt**	**Cost of total debt**	**Cost of total debt**	**Cost of total debt**
	0 year forward	1 year forward	2 years forward	3 years forward	4 years forward	5 years forward
Regression	(1)	(2)	(3)	(4)	(5)	(6)
Issued green bonds	0.020***	0.010*	0.014***	0.003	0.002	0.010**
	(0.006)	(0.006)	(0.004)	(0.004)	(0.005)	(0.005)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	13,327	10,365	8,048	6,078	4,188	2,470
R^2	0.345	0.353	0.368	0.510	0.500	0.437

The robust standard errors are shown in parentheses. ∗, ∗∗, ∗∗∗ represent significance at the 10%, 5% and 1% levels, respectively.

The value of the coefficients of the positive relationship between green bond issuance and Cost of total debt does not change, but the significance of some of the coefficients does. For example, the p-value of the Issued green bonds coefficient of regression 2 increases from 0.055 to 0.062, while that of regression 4 decreases from 0.577 to 0.471. However, the coefficients of the significant regressions remain strong and significant, so the clustered standard errors do not affect the positive relationship between green bond issuance and the

future cost of debt capital. In fact, it gives an indication that the relationship is fairly robust and that hypothesis 3 can be rejected.

6 Conclusion and discussion

This research sought to answer the following research question:

"What is the effect of green bond issuance on short- and long-term firm performance and the cost of debt capital of the issuing firm in the future?"

To answer this research question, Bloomberg's Fixed Income database is used to find European and US companies and governments that have issued green bonds between January 1, 2015 and December 31, 2022. The same database is used to find companies that have issued conventional bonds and to obtain data on the characteristics of the green and conventional bonds. In addition, Standard & Poor's CompuStat North America database is used to get data from the financial statements about the US firms and Standard & Poor's CompuStat Global database to obtain financial data on the European firms. The companies that have issued green bonds are the treatment group of this research and the companies that do not issue green bonds are the control group. To test the hypotheses, DiD regressions without fixed effects, with industry, country and year fixed effects and with firm and year fixed effects are used. From these regressions, the best-fitting model is selected, which is performed with the first, second and third leads of the short- and long-term firm performance variables instead of the contemporary ones as a robustness check. For the future cost of debt capital, regressions are performed with the first, second, third, fourth and fifth leads of the cost of debt capital variable instead of the contemporary ones as a robustness check.

The research question was examined on the basis of three hypotheses. Hypothesis 1 is: *"Green bond issuance has a positive direct effect on short-term firm value."* The results show that there is a statistically significant positive relationship between green bond issuance and both Tobin's Q and ROE and that this effect is even larger in the long term. Thus, from these results it can be deduced with a considerable degree of certainty that green bond issuance has a positive effect on short-term firm value compared to not issuing green bonds, so hypothesis 1 cannot be rejected. This result is consistent with what Flammer (2021), Tan et al. (2022) and Khurram et al. (2023) found in their studies. The positive effect of green bond issuance on short-term firm value could be explained by the fact that the issuance of green bonds leads to (media) attention, which increases the share price of the firm (Flammer, 2021) and also improves the company's reputation, because the company visibly sends a signal that it is committed to the environment and wants to become more sustainable (Tang and Zhang, 2020; Huang, 2022). In addition, the funds obtained from the green bonds could be spent on positive NPV projects and used for innovation and technological development, which leads to cost reductions and a higher firm value in both the short- and long-term (Yeow and Ng, 2021; Zhou and Cui, 2019; Tan et al., 2022).

Hypothesis 2 is: *"Green bond issuance has a positive direct effect on long-term financial performance."* The results show that there is no statistically significant relationship between green bond issuance and both ROA and ROS. Thus, from these results it can be deduced with some degree of certainty that there is no statistically significant relationship between green bond issuance and long-term financial performance, so hypothesis 2 can be rejected. This result is consistent with what Yeow and Ng (2021) found in their study. The fact that there is no statistically significant relationship between green bond issuance and long-term financial performance could be explained by the fact that companies may have spent the funds obtained through the green bonds on sustainable technology and green innovation, but that these projects have failed and do not contribute to making the company (more) sustainable in an efficient manner (Wang et al., 2022; Khurram et al., 2023). As a result, these green investments do not provide cost reductions or a competitive advantage and therefore do not generate more profits than before (Tan et al., 2022; Zhou and Cui, 2019). In addition, it could be that green bond issuance only has an effect on the short-term share price and firm value, but that in the long term it does not contribute to (environmental) performance and an improved reputation, so that the long-term profitability and firm performance do not increase (Yeow and Ng, 2021).

Hypothesis 3 is: *"Green bond issuance has a negative direct effect on the cost of debt capital of the issuing firm in the future."* The results show that there is a statistically significant positive relationship between green bond issuance and Cost of total debt and that this effect persists in the long term. Thus, from these results it can be deduced with some degree of certainty that green bond issuance has a positive effect on cost of debt capital of the issuing firm in the future compared to not issuing green bonds, so hypothesis 3 can be rejected. This result is not consistent with the existing literature. Studies such as Zhang et al. (2021) and Hyun et al. (2020), found a negative relationship between green bond issuance and cost of debt capital. The positive relationship between green bond issuance and cost of debt capital of the issuing firm in the future could be explained by the fact that the company already has a bad reputation and potential bondholders are afraid that the company may be guilty of greenwashing and that it will not use the funds from the green bond in an environmentally friendly manner (Flammer, 2021; Tang and Zhang, 2020). Therefore, the company's reputation does not improve, because investors are not convinced that the company wants to become more sustainable and wants to invest in green development (Zerbib, 2019; Zhang et al., 2021). As a result, the company is actually perceived as riskier by investors, which prevents the company from obtaining a better credit rating, which in turn increases the cost of debt capital in both the short- and long-term (Sun and Cui, 2014; Jiraporn et al., 2014).

Thus, the final answer to the research question is that there is a positive effect of green bond issuance on short-term firm value and no effect on long-term financial performance. In addition, there is a positive effect of green bond issuance on the cost of debt capital of the

issuing firm in the future.

Based on the results, a recommendation that can be made to companies is to issue green bonds, because in this way they can improve the company's reputation, because the company visibly sends a signal that it is committed to the environment and wants to become more sustainable. In addition, the funds obtained from the green bonds could be spent on positive NPV projects and invested in green innovation and sustainable technology, which leads to cost reductions and a competitive advantage, which results in a higher firm value in both the short- and long-term. A recommendation that can be made to governments is that it should encourage the issuance of green bonds as it is beneficial for both the companies and the environment, because it provides companies with financial benefits in the form of short- and long-term firm value and it makes companies more sustainable, which helps protect and preserve the environment. The government can do this by reimbursing the issuance costs and the costs of requesting a certificate to companies. This ensures that companies become familiar with and see the advantages of sustainability and green bonds and that both the global climate goals can be achieved and economic prosperity is created for society.

This research has a number of shortcomings. For example, it would have been better if the green bond issuing companies had been matched with the other companies based on a matching method, such as Propensity Score Matching, before the DiD regressions were performed, so that the treatment group and control group were more comparable. In addition, it is a way to tackle sample selection bias and the heterogeneity and endogeneity problem. Unfortunately, there are only 201 green bond issuing companies in the sample, which would be even fewer after the matching, causing the results to be less reliable and significant. In addition, many European green bonds could not be matched with the financial data, because the bond ISIN must first be linked to the Equity ISIN, which was often missing. This means that there are fewer green bonds in the sample than there actually were at the beginning, which is also because the DiD method only includes the first green bond issuance for every firm, causing even more green bond observations to be lost. This means that less strong conclusions can be derived from the results, because this also affects the significance (levels). Moreover, the institutional ownership and ESG score of the companies could not be collected as control variables, although it can influence firm performance, as the literature shows. This effect now ends up in the error term, which can lead to omitted variable bias and influence the results. The same applies to the bond characteristics, which could also not be added as control variables to the regressions, because these are only available for companies that have issued bonds and that is only a very small part of both the treatment and control group. Furthermore, it would have been better to choose one continent for this research instead of two. As a result, two different databases had to be used to collect financial data, which could result in variables being defined differently or important variables being missing, such as the market value of the

equity in the Standard & Poor's CompuStat Global database. This can complicate the comparison of the variables of European and US companies and lead to poorer quality of the results. In addition, the control group consists not only of companies that have issued conventional bonds, but also of companies that have not issued any bonds at all, which may lead to large differences within the control group, making the DiD results less reliable. Unfortunately, there were many duplicates in the group with conventional bond issuing companies, which would lead to few observations remaining, so a control group was chosen with all companies that did not issue green bonds.

Further research could conduct this study again with a wider number of years as the sample period, so that there are more green bonds in the sample and a matching method can be used. In addition, a longer sample period can be used to examine the effect of green bond issuance on firm performance in the long term, so five or ten years into the future instead of three. Moreover, previous research has paid little attention to the cost of debt capital in the future. In this study, only one measure of the cost of debt capital and only the DiD method with fixed effects are used. Further research could expand this by testing the relationship with another measure of the cost of debt capital or another research method. If there is a larger sample of green bonds with more years of data, this relationship between green bond issuance and the cost of debt capital several years after the year of issuance of the green bond, for example ten years, can also be better investigated and result in more consensus in the literature. In addition, future research could focus on the effect of green bond issuance on innovation and R&D and technological development. The regressions in this study show that there is a negative relationship between R&D intensity and long-term financial performance, while a positive relationship would be expected. Further research could examine whether the funds obtained through green bonds and invested in R&D actually lead to innovation and improved environmental performance, which in turn can lead to an increase in profitability and financial performance.

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