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Green bond benefits:

An analysis of the short- and long-term performance of firms that issue green bonds

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Abstract

The rising popularity of corporate green bonds, a fixed income instrument aimed at financing environmentally responsible projects, raises questions on its impact on firm value. This study analyses short- and long-term performance of green bond issuing firms, post-issuance and in the context of mergers & acquisitions. Endogeneity concerns are mitigated by constructing a Mahalanobis distance control group. An event study approach confirms earlier research and finds positive announcement returns for a green bond announcement and merger announcements by green bond firms. Multi-factor models indicate similar excess returns in the long-term. Although overall, the study finds a positive relation between green bond issuance and short- and long-term performance, results are not robust to various tests.

Keywords: Green bonds, Corporate Social Responsibility, Mergers & Acquistions, Stakeholder value maximization, Announcement returns, Multi-factor model, difference-in-difference, Mahalanobis distance, Cross-sectional analysis

JEL Classification: G14, G32, G34, Q56, M14

Table of Contents

List of Tables

List of Figures

1 Introduction

In the 2017 Carbon Majors report, it was estimated that over 70% of global emissions is caused by the top 100 polluting companies (Climate Accountability Institute, 2017). The corporate sector as a whole does not maintain a good reputation for its contribution to environmental causes and clean energy. While many industries have seen a shift in recent years, the corporate sector, coming from far, is catching up quickly. Recently, analysts at Morgan Stanley have referred to the 'Green Bond Boom', when describing the exponential growth of green bonds. Although not formally defined, a green bond is a fixed income instrument, which proceeds are to be used for environmental and climate-related projects, such as renewable energy or sustainable technology. Typically, the bonds are backed by the issuing entity's entire balance sheet (Flammer, 2021). This allows investors to invest in green projects at no increased risk.

To illustrate the magnitude of the green bond boom, the market doubled between 2015 and 2016 to 81 billion annually (Morgan Stanley, 2018). In 2019 the green bond market raised 271 billion worldwide, which translates to about 4% of total debt issuance. Covid-19 has slightly impacted the growth in 2020 (The Economist, 2020). For 2021, the Swedish Bank SEB predicts a new surge in green bonds to 500 billion. Although not all banks share similar optimism, analysts agree that the Biden administration will have a significant positive effect. Some analysts speculate that increased demand could even lead to a "greenium", making green bonds more expensive for investors, although offering similar risk as its traditional counterpart. However, the existence of a greenium is disputed by others (Nauman, 2021; Flammer, 2021).

Although there is no doubt that green bonds are booming, industry experts are raising questions on the value of the sustainable debt instrument. At its current stage, hard evidence in the form of carbon reduction remains arbitrary (Flammer, 2021; Ehlers et al., 2020). However, the exponential growth of the green bond market indicates that green bonds may contribute to firm value through other channels. Although companies are increasingly aware of their public image and impact on the environment, the surge in popularity suggests that green bonds may offer financial benefits as well.

1.1 Research question

This study analyses the short- and long-term value creation of green bonds. Several event studies have shown positive abnormal returns following a company's Corporate Social Responsibility (CSR) efforts (Flammer, 2013; Krüger, 2015). This method has subsequently been extended to green bonds (Flammer, 2021; Tang & Zhang, 2020). By performing an event study for the time window before and after the issuance of green bonds, one can determine the Cumulative Abnormal Return (CAR). Earlier research on CSR and green bonds has mainly focused on short-term value creation. As an event study is limited to a specific point in time, it might fail to capture the full value creation. It is possible that the value of issuing a green bond is not truly reflected in the share price at the time of the announcement. This effect can be measured in terms of long-term operating performance. Extending the analysis to both short- and long-term value creation will help gain a better understanding of the value of green bonds.

In this study, merger & acquisition (M&A) activity is analysed to determine corporate performance.

In the remainder of this study, M&A activity is referred to as mergers, which include mergers as well as takeovers. Following the rationale of Deng et al. (2013), there are two main reasons to focus on mergers when considering performance of firms. First of all, a merger is an important corporate investment decision, which greatly affects shareholder value. Second of all, the focus on mergers helps to mitigate endogeneity concerns. When comparing firms that issue green bonds to firms that do not, one needs to assess if there are inherent differences between those firms. As a merger is often a largely unanticipated event, the likelihood of reversed causality can be reduced. The aim of this study is summarized in the following research question.

What is the effect of green bond issuance on short- and long-term firm performance, post-issuance and post-merger?

The research question will be supported by the following hypothesis:

H1: firms that issue green bonds perform better on the short-term post-issuance.
H2: firms that issue green bonds perform better on long-term post-issuance.
H3: the cumulative abnormal returns following a merger of firms that have issued green bonds are higher than similar firms that have not issued green bonds.
H4: the post-merger, long-term operating performance of firms that have issued green bonds is higher than firms that have not issued green bonds

This study starts by covering existing literature regarding the development of green bonds, Corporate Social Responsibility (CSR) and the relation to merger and firm performance. Other research has indicated several motives for firms to issue a green bond or to engage in environmentally responsible initiatives. First of all, some companies issue green bonds to falsely claim their commitment to the environment (greenwashing). Second of all, companies are thought to exploit the focus on environmental awareness by attempting to obtain cheaper financing. Third, green bonds are expected to increase media attention of the firm, which may attract more investors. Finally, green bond issuing firms may signal the market with a credible commitment to environmental causes. Most recent literature has found substantial evidence for the increased media attention and signalling arguments and contradicted greenwashing and cost-of-capital motives (Flammer, 2021; Tang & Zhang, 2020). Earlier research on CSR has fueled the discussion on stakeholders and shareholders. This debate revolves around the question whether socially responsible firms are acting in the interest of their shareholders. Recent studies have indicated that socially responsible firms perform better in relation to mergers (Deng et al., 2013).

The empirical analysis is centered around an extensive Bloomberg data set of approximately 4000 green bonds. An event study approach aims to understand the short-term performance of firms surrounding a green bond issue. The results of this analysis are discussed in section 5. Contrary to earlier research by Flammer (2021) and Tang & Zhang (2020), this study finds no robust evidence for positive returns surrounding a green bond announcement. Although the analyses performed mostly confirm earlier findings, these results do not survive various robustness tests. The long-term operating performance does indicate an advantage for green bond issuing firms. By constructing several multi-factor models, the long-term stock performance indicates that green bond firms outperform their respective benchmarks. However, this result does not hold when considering a value-weighted portfolio. It must be noted that this part of the analysis is limited to US firms only due to data availability.

Section 6 analyses the performance post-merger of firms that have issued a green bond, compared to firms that have not. The control group is created through a matching approach with various control variables. In the short term, mergers by green bond firms yield positive announcement returns. However, this result is not robust to different indices and cross-sectional regression analyses. Mergers in the control group do not yield statistically significant positive returns. The long-term performance is analyzed by comparing cashflow post-merger and a multi-factor model of stock performance. Both analyses point towards improved performance for mergers by green bond firms. This result remains intact when including year and firm fixed effects, to account for time and firm-varying differences.

The findings of this study provide mixed evidence for the increased performance of firms that issue green bonds. Although most analyses confirm the findings of earlier research, the results do not always pass robustness tests. Differences with earlier studies may be explained by a more recent and larger sample size used in this study. Furthermore, the nature of the relation between green bond issuance and firm performance raises endogeneity concerns, which cannot be fully corrected for.

The remainder of this paper is structured as follows. Section 2 covers the existing body of literature on CSR, green bonds and merger performance. The data used for the empirical analysis is presented in section 3. Section 4 contains the empirical methodology and the matching approach. Results on firm performance is split into two parts. Section 5 covers firm performance post-issuance, while section 6 compares firm performance post-merger of green bond firms vs. non-green bond firms. Finally, section 7 shares concluding remarks and recommendations for future research.

1.2 Academic relevance

This study's contribution to existing literature is threefold. First of all, the literature on green bonds is limited when compared to the surge of the green bond market. Earlier literature has focused mainly on sovereign green bonds, the pricing of sustainable debt instruments and the arguments for issuance. Long-term shareholder value of corporate green bonds remains a scarcely researched topic. A better understanding of the economic viability of green bonds, for firms as well as shareholders, is needed to reach its full potential. Second of all, this is the first study that researches the long-term shareholder value in relation to mergers. Mergers are proper indicators of corporate performance. Incorporating mergers can extent the analysis for a better understanding of long-term value of green bonds. Analyzing share prices around and after merger announcements can provide valuable insights into corporate performance and differences between firms. Finally, the findings of this paper will improve the understanding of the stakeholder vs. shareholder debate, as will be explained in the following section.

2 Literature review

2.1 Rationale behind green bonds

Why do firms choose to issue green bonds? In general, it can be said that green bonds are more restrictive in nature and are subject to higher administrative and compliance costs. Given that traditional bonds are easier and less costly to issue, companies could also use the proceeds of traditional bonds for green projects. At first glance, issuing green bonds seems costly and cumbersome. Earlier research has come up with various explanations as to why firms choose to issue green bonds over traditional debt.

In recent years, society demanding a higher standard of corporate responsibility. Especially regarding the environment, governments, municipalities and NGOs are challenging firms to reduce their carbon emission and limit the use of natural resources. As this is often less desirable, costly or otherwise difficult from the firm's perspective, firms have an incentive to overstate their commitment to the environment, often referred to as 'greenwashing'. In theory, green bonds can be used for that specific purpose. As there is not a single governing entity for green bonds, a firm can issue sustainable debt purely to mislead customers and stakeholders on environmental commitment. Although green bonds can be used for this purpose, the cost of issuing should form an initial obstacle. Other measures like social media campaigns and corporate philanthropy may seem less costly to undertake (Flammer, 2021).

The validity of the greenwashing argument for green bonds can be easily tested and has been the subject of earlier research. If the greenwashing argument does not hold, the issuance of green bonds should have a positive effect on environmental performance post-issuance. Research by Flammer (2021) confirms this hypothesis. ASSET4 environment ratings are shown to increase by 7 percentage points following the issuance of green bonds. Furthermore, emissions are reduced by 13 tons of carbon dioxide for every $1M in assets. However, as mentioned earlier, research by the Bank for International Settlements reached contradictory conclusions (Ehlers et al., 2020). In recent years, third-party initiatives to certify green bonds and thereby reduce the risk of greenwashing, are becoming more prominent in the market. Research by Flammer (2021) shows that certification by a third party increases environmental scores.

A second argument for green bonds could lie in the cost of capital. Some institutional and private investors value environmental benefits over maximizing returns. When they are willing to accept a lower yield on a green bond compared to a traditional bond, this could lead to a lower cost of capital for green projects. It could even be the case that institutional investors experience external pressure to invest in sustainable initiatives. The corporate sector as a whole is not known for its contribution to environmental causes and has been subject to criticism. Earlier research on a potential premium for green bonds provides mixed results (Baker et al., 2018; Karpf & Mandel, 2017; Zerbib, 2019). A more recent article has addressed these discrepancies and provided an explanation. According to Larcker & Watts (2020), mixed results can be attributed to a flawed methodology, producing biased estimates. They provide a new research design that incorporates a matching methodology. By matching a green bond to a nearly identical traditional bond of the same issuer, they test for pricing differences. They find no evidence for a premium on green bonds. Although it may be the case that investors are prepared to pay extra for sustainable development, it is difficult to conclude that firms issue green bonds with the primary intention of obtaining cheap financing.

Research by Tang & Zhang (2020) provides an additional rationale for green bonds. They suggest that green bonds can be used to increase the media attention of a firm. This exposure will signal the market that a firm is committed to sustainable development. Providing investors with green investment opportunities and increased media exposure may attract more investors to a firm. Tang & Zhang (2020) show that average daily turnover of a stock increases significantly around the issuance date. The reaction of the stock market is stronger for first-time issuers and for corporate issuers, compared to institutions. For existing shareholders, the positive announcement returns are an indicator of increased shareholder value. However, this does not prove that firms primarily issue green bonds to increase their media attention and consequently, investor base.

The final argument for green bonds revolves around signalling the market. Contrary to greenwashing, the signalling theory argues that firms issue green bonds to signal a credible environmental commitment to the market (Flammer, 2021; Tang & Zhang, 2020). Signalling theory assumes information asymmetry between companies and investors. As investors face transaction costs when deciding in which companies to invest, it is in a company's best interest to signal the market. It can do so by taking actions that credibly convey information on strategy or commitment. Issuing a green bond is likely credible, because a company commits a significant amount of capital to a sustainable project. As the majority of green bonds is certified by a third party, it becomes less worthwhile to issue a green bond that is not actually green. Compliance with the standard of the certifying party requires time and effort from the issuing company. Furthermore, compliance is often monitored post-issuance and if a company fails to deliver on its promises, a certification can be revoked.

Signalling and increased attention arguments provide testable hypotheses. Several event studies have been undertaken to test these theories. Event study methodology usually entails an assessment of the stock price reaction to a specific event. In this case, the issuance of green bonds. When companies send a credible signal to the market for their commitment to the environment, by issuing a green bond, the share price should indicate positive abnormal returns. As shown by Tang & Zhang (2020), the positive abnormal returns are higher for certified green bonds and first-time issuers. Furthermore, a credible commitment to the environment should attract long-term, committed investors that are sensitive to the environment. Flammer (2021) shows that a green bond does indeed attract long-term and green investors.

2.2 Shareholder value

Berle and Dodd, both American lawyers in the 1930s shared a renowned debate on the responsibility of corporations. In essence, they disagreed on whether corporations were accountable to their shareholders only or to society as a whole. This debate is especially interesting in light of Corporate Social Responsibility (CSR) (Berle & Means, 1991). For socially responsible firms the question arises whether they can act in the interest of their shareholders and other stakeholders at the same time. In line with the separation of ownership and control, managers are the ones that decide on engaging in CSR activities. This division reveals the agency problem that surrounds CSR. It has been heavily debated in earlier literature whether value-maximizing corporate governance leaves room for socially responsible behaviour. Economist Milton Friedman has once claimed that the only responsibility a firm has is to make profits. If businesses were to focus on anything other than making profits, it would harm the foundations of a free society (New York Times Magazine, 1970).

Empirical research on Corporate Social Responsibility (CSR) has split the debate into two opposing views. On the one hand, there is the stakeholder value maximization view, which argues that focusing on the value creation of all stakeholders of the firm can increase support for the firm in its operation. This theory implies that a firm is also depending on stakeholders for its success, not only shareholders. This line of reasoning builds on earlier theories like the theory of the firm and contract theory (Coase, 1937; Alchian & Demsetz, 1972).

On the other hand, there is the shareholder expense view, which focuses on the decisions of managers to support socially responsible activities that are not in the interest of shareholders. In that case, stakeholders benefit at the expense of shareholders, resulting in a transfer of wealth from shareholders to stakeholders. For instance, a firm that is conscious of the environment could set emission goals that puts it at a disadvantage to competitors. Although this will satisfy stakeholders, like environmentalists, residents close to the production facility, it may lead to a loss in profitability. Effectively wealth is transferred from shareholders to stakeholders (Friedman, 2007).

In general, CSR projects are long-term investments that rarely have an immediate effect on shareholder wealth. In that regard, CSR activities are comparable to green bonds. As earlier research has shown that by issuing green bonds, firms likely send a credible signal to the market regarding their commitment to the environment, the theories on agency problems can be extended to green bonds as well. Following the stakeholder value maximization view, firms that issue green bonds can expect higher announcement returns and better operating performance post-issuance. The opposite holds for the shareholder expense view, which would predict lower announcement returns and worse operating performance, as the issuance of green bonds is not in the interest of shareholders. The literature on agency problems and shareholder value therefore provides testable predictions that help shed light on the motivation behind green bonds.

2.3 Mergers & Acquisitions

The surge in global M&A deals in recent decades has made mergers a dominant topic in corporate finance research. In general, mergers are interesting events in the life of a company and have significant implications on future value. Mergers can eliminate competition, increase market share and create synergies that may greatly reduce the cost of operations. For publicly traded firms, empirical research has shown that mergers have a significant effect on shareholder value (Bradley et al., 1988). The share price fluctuation surrounding the announcement date of a merger is therefore a good indicator of the value of the merger as perceived by the market. To successfully execute a merger, a firm depends on the support of the majority of its shareholders.

Furthermore, other stakeholders can have a significant effect on the outcome of a merger. For instance, regulators or environmentalists could complicate the firm's operation in a later stage if they disapprove of the merger. The relation to non-investor stakeholders can be broadly characterized by implicit and explicit claims, which the firm makes to both groups (Deng et al., 2013). An example of an explicit claim is a wage contract with employees. A firm cannot default on those contracts. However, firms also make implicit claims that have no legal standing. For instance, the promise to customers about future product capabilities, or commitment to stakeholders to cut down emissions. The value of the implicit contracts is determined by the perception of stakeholders, as firms can default on implicit contracts without legal retribution. (Cornell & Shapiro, 1987). The stakeholder value maximization theory promotes corporate strategy that includes the interests of all stakeholders of the firm. When firms maximize stakeholder value, the interests between shareholders and other stakeholders are better aligned. This theory is especially important in the context of mergers, as they tend to involve many new and previously existing stakeholders. The new, combined firm will often be forced to recalibrate its relation with stakeholders (Jensen, 2001; Jawahar & McLaughlin, 2001).

Translated to this study, this theory predicts that firms that engage more in causes to support the environment, will tend to have a better reputation to their stakeholders regarding credibility of their intentions. Their commitment to environmental causes will increase the willingness of stakeholders to support the firm's operation. This in turn is beneficial for the performance of the firm, which will ultimately increase shareholder wealth. The stakeholder value maximization theory is contradictory to the shareholder expense view, which stipulates that firms should only focus on the interests of shareholders. Any other undertakings, like managers engaging in CSR activity, are considered to be at the expense of shareholder wealth (Deng et al., 2013).

Finally, as firm value and shareholder wealth depend on a wide variety of factors, the risk of endogeneity is often present when researching specific effects, especially with a relatively new phenomenon like green bonds. It is plausible that firms that issue green bonds are inherently different from firms that do not. Issuance of green bonds could be a result of firm performance in the past. This can create reverse causality amongst the researched variables and may produce a biased result. By including mergers in the scope of this research, reverse endogeneity concerns may be diminished. Mergers are important events in corporate strategy and are largely unanticipated, focusing on merger events can potentially reduce the risk of reverse causality in relation to green bonds. The stakeholder value maximization theory predicts that green bond acquirers perform better in mergers compared to similar other firms, as they enjoy support by stakeholders and therefore ultimately benefit shareholders. Furthermore, it is likely that green bonds, as a commitment to the environment, increase the firms' intangible assets, the stock returns when announced may not fully incorporate the added value. Therefore, stakeholder value maximization predicts that mergers by green bond firms experience better post-merger performance than non-green bond firm mergers (Deng et al., 2013).

2.4 Merger waves

Earlier empirical research has found that mergers are not evenly distributed over time. Instead, they cluster in different waves (Gort, 1969). This finding has sparked research into the cause of this phenomenon. Broadly categorized, the literature can be divided into two schools of thought. On the one hand, there is the Neoclassical explanation, which is based on the assumption that economic disturbance leads to industry reorganization. In this model, merger waves are a rational consequence of technological, regulatory or economic shocks. On the other hand, merger waves are approached from a behavioural perspective. This theory is based on misvaluation of company stocks. Stock financed transactions are accepted by target firms either because of imperfect information or shorter time horizons. Various theories on the driving forces behind merger waves will be discussed below.

From a Neoclassical perspective, the driving force in merger activity stems from industry, regulatory and economic shocks. Mitchell & Mulherin (1996) find that takeover and restructuring activity in a particular industry often cluster within a short time span. An industry shock, like a sudden shock in sales due to technological progress, or a demographic change, is found to be directly related to industry takeover activity. The same relation is present in regulatory shocks. If an industry experiences unanticipated changes in regulation, this can have a substantial impact on the firms operating within that industry. To catch up or adapt, firms may consider takeovers. Vice versa, struggling firms may become viable takeover targets when regulation further limits the firm's growth perspective.

The Neoclassical explanation is expanded with the capital liquidity argument. Harford (2005) argues that besides technological, regulatory or economic shocks, capital liquidity in the market impacts the rate at which mergers take place. The theory centers around the assumption that higher market valuations relax financing constraints. Firms with higher cashflows have increased fundamental value and fewer financial constraints. Therefore, a shock of industry, regulation or the economy as a whole will only generate a merger wave when sufficient capital liquidity exists to accommodate the reallocation of assets.

An explanation based on misvaluation is proposed by Shleifer & Vishny (2003). This theory approaches mergers acquisition activities from a behavioural perspective. They argue that misvaluation brings an incentive for acquiring firms to get their equity overvalued. The overvalued equity finances stock acquisitions of less overvalued targets. This strategy might increase their chances of survival, as otherwise the firm is at risk of becoming a takeover target. On the other hand, target shareholders are hurt by the transaction in the long run. Target managers engage in the merger due to self-interest and a short horizon. They are thought to sell out quickly when their stock is overvalued and do not maximize long-term shareholder value.

According to Rhodes-Kropf & Viswanathan (2004) even fully rational managers can make mistakes when participating in a merger. They provide support for the theory that mistakes could be the result of misvaluation. A firm is considered misvalued based on the constructed Market to Book ratio (M/B). More specifically, higher overvaluation in the market increases the chance that a merger takes place. In the long run, merger waves can occur due to misvaluation, even when there is no reason for the merger to take place. Besides the increased probability of a merger taking place, misvaluation can impact the financing decision of the deal. Periods of overvaluation increases the likeliness of a stock financed transaction. Managers of the target firm are more prone to accept an offer when the market is misvalued. An offer that surpasses standalone firm value is often accepted based on the fiduciary responsibility of managers. Finally, Rhodes-Kropf & Viswanathan (2004) show that the market reacts more positively to a cash financed transaction compared to a stock financed transaction.

A second study by Rhodes-Kropf et al. (2005) compares both theories. Again, they prove that misvaluation is positively correlated with merger intensity. Furthermore they find supporting evidence to the theory proposed by Shleifer & Vishny (2003) and Rhodes-Kropf & Viswanathan (2004). According to their findings, overvalued firms dominate as bidders during merger waves. Misvaluation accounts for approximately 15% of merger activity at sector level. Merger activity clusters in overvalued sectors. Remarkably, after controlling for firm-specific and time-specific sector errors, the empirical method produces evidence for low long-run value to book firms buying high long-run value to book firms. This implicates that low-growth firms buy high-growth firms.

As this study is centered around merger performance of green bond firms, understanding of mergers in general is essential. The clustering of mergers in specific industries or periods may implicate that subsequent merger performance is affected. The difference between green bond firms and other firms can make them more prone to merger waves. For instance, green bond firms may be less financially constrained than other firms. On the other hand, they can be subject to higher misvaluation. To properly interpret further analysis on merger performance, it is crucial to establish a level playing field. If green bond firms are more (or less) sensitive to merger waves, this impacts further comparison of performance.

3 Data

3.1 Main data sources

The green bond data set used in this study is extracted from Bloomberg's fixed income database. In the selection, all corporate bonds with a green indicator are included. For obvious reasons, sovereign bonds are excluded from the analysis. This yields a little under 4000 green bonds issued in the period of 2007 - 2021(03). An overview of the green bonds issued per year is presented in table 1. The data set gives insight into the development of green bond issuance since the start in 2007. The most recent years have seen a year-on-year increase with 925 green bonds issued in 2020. At the time of writing the data set only included the first quarter of 2021. Bloomberg supplies a wide variety of information on each bond, such as the amount, maturity, certification as well as announcement dates and several credit ratings. Furthermore, every bond is categorized into a 2-digit Standard Industry Classification (SIC) code. An overview of the bonds per industry is presented in table A1 in the appendix. The majority of green bonds is issued by financial institutions and governments. Unsurprisingly, these are followed closely by the energy and utility sectors. To allow comparison, bonds issued in different currencies are converted to USD.

Table 1: Green bonds by year

Summary statistics		
Year issued	Count	Amount issued (Billion USD)
2007	1	0,8
2008	7	0,4
2009	11	0,9
2010	55	4,4
2011	30	1,2
2012	22	2,2
2013	42	15,2
2014	133	34,1
2015	325	48,8
2016	261	90,8
2017	437	153,3
2018	526	151,3
2019	785	241,5
2020	925	263,7
2021	184	47,2
Total	**3744**	**1056,0**

This table presents the green bonds issued per year and the cumulative amount issued that year in billion USD.

The merger sample is constructed by using the Thomson One database. Corporate mergers of public firms are selected in the period between 2005 and 2021(03). The selection is limited to China, the EU and the US as the majority of green bonds are issued in those regions. Furthermore, only publicly traded firms are included. The Thomson database supplies the announcement date, deal size and industry of target and acquirer. The total sample consists of over 142,000 mergers and acquisitions. Table 2 presents an overview of the distribution of deals per year throughout the sample. The number of deals was the highest in early sample years, while average transaction size increases over the years. The deal information per country is shown in table A2 in the appendix. Over half of the deals are undertaken by US-based acquirers, while only 15% of M&A activity takes place in China. Finally, the deals are categorized by industry in table A3 in the appendix.

Table 2: M&A deals by year

Summary statistics			
Year	Number of deals	Average transaction value ($mil)	% of total
2005	8.962	304,5	6,28%
2006	10.206	351,9	7,15%
2007	12.008	300,4	8,41%
2008	10.382	235,8	7,27%
2009	7.822	200,8	5,48%
2010	9.114	268,1	6,38%
2011	9.422	253,0	6,60%
2012	8.091	294,3	5,67%
2013	7.528	357,1	5,27%
2014	8.924	388,6	6,25%
2015	9.622	486,6	6,74%
2016	8.545	406,5	5,98%
2017	8.449	401,1	5,92%
2018	8.937	463,6	6,26%
2019	6.819	470,3	4,78%
2020	6.169	364,4	4,32%
2021	1.785	508,2	1,25%
Total	**142.785**	**347,1**	**100,00%**

This table presents the M&A deal sample sorted by years. This data is extracted from the Thomson One database based on the following criteria: (1) Public status of the acquirer. (2) Deal announced between 01-01-2005 and 31-03-2021. (3) The acquirer is based in Europe, North America or China.

Finally, the CRSP database supplies stock prices to analyse the stock returns surrounding announcement dates of green bonds and mergers. As CRSP mainly covers the US, the stock price database is extended by using the Compustat Global daily stock file. A limitation of the Compustat database is the missing return variable and index variables. These have to be constructed using other variables. Furthermore, the index return variable is missing in Compustat Global. Therefore, the WRDS country index is used as a proxy for market return. The country index is based on the country's largest stock index and is therefore a good proxy for market performance.

For long term stock price analysis, several factor models are considered. The factors for these models are constructed using the daily factor data from the Kenneth R. French website. A drawback in this approach is the fact that this data is only available for the US. Although the US is very well-documented in this regard, other countries do not offer similar benchmarks. This section of the research is therefore limited to US firms.

3.2 Control variables

To properly distil the effects of green bonds, it is important to control for firm-specific characteristics that might impact the relation. For instance, firm size, previous returns and leverage are important indicators of a firm's performance. Well-performing firms may be more likely to issue green bonds and vice versa. Therefore, firm-level data is gathered from the Compustat Global and Compustat North America databases. These databases supply firm financials on a quarterly basis. Following the research of Flammer (2021), the following control variables are constructed using the combined Compustat database. These variables together are used in earlier research as parameters to find comparable firms (Almeida et al., 2009; Flammer, 2021). All raw variables are winsorized at the 1^{st} and 99^{th} percentile to reduce the impact of potential outliers. First of all, a measure for *size* is constructed by taking the natural logarithm of the total assets. *Return on assets* (ROA) is the ratio of operating income before depreciation to total assets. *Tobin's Q* is constructed by taking the ratio of total assets, combined with the market capitalization minus the common equity, deferred taxes and investment tax credit. *Long-term leverage* is comprised of the ratio of total assets to total long-term debt. *Cash holdings* are determined as the ratio of cash and short-term investments to total assets. *Cashflow* is calculated by taking the ratio of net income plus depreciation and amortization to the lag of quarterly property, plant and equipment. Finally, *Investment* is the ratio of quarterly capital expenditures to the lag of quarterly property, plant and equipment. A schematic overview of the construction of control variables, including references to the respective database, is presented in table 3.

Table 3: Control variables

Variable computation			
Variable	Description	Compustat North America	Compustat Global
Investment	Ratio of quarterly capital expenditures to the lag of quarterly property, plant and equipment	(capxy) / (ppentq)	(capxy) / (ppentq)
Tobin's Q	Ratio of total assets plus market capitalization minus common equity minus deferred taxed and investment tax credit	(atq + prccq×cshoq - ceqq - txditcq) / (atq).	(atq + [market cap compustat] + ceqq + txdcy) / (atq)
Cashflow	Ratio of net income plus depreciation and amortization to lag of quarterly property, plant and equipment	(ibq + dpq)	(ibq + dpq)
Size	Log of assets	Log (atq)	Log (atq)
Cash holdings	Ratio of cash and short-term investments to total assets	(cheq) / (atq)	(cheq) / (atq)
Long-term leverage	Ratio of total long-term debt to total assets	(dd1 + dltt) / (atq)	(dlttq) / (atq)
Δ	Change from t-2 to t-1	(t-1) – (t-2)	(t-1) – (t-2)

This table presents the calculation methods used to calculate the control variables from the raw variables of the respective data sources. The data for the control variables is extracted from two different datasets, which contain different variables. Therefore, calculation methods differ between data sets.

3.3 Matching methodology

As described earlier, mergers can have a significant effect on shareholder wealth and are therefore important in the research on firm performance with or without green bonds. An inevitable obstacle when researching green bonds is the risk of an unobservable factor influencing a firm's decision of issuance. Although a company can have many different reasons to issue a fixed income instrument, it cannot be concluded that issuance of green bonds is a random event. There may be an unobserved factor driving the green bond market. This creates an empirical challenge, as it is not possible to create an experimental setting in which the post-merger performance of non-green bond firms is compared to their performance should they have issued a green bond. One could make a compelling argument that green bond issuance is endogenous to firm performance. For example, it could be the case that only well-performing, healthy firms issue green bonds. Although controlling for firm-level characteristics can reduce this effect, it can still persist through unobservable factors.

Other authors have attempted to tackle this problem by using an instrumental variable (Deng et al., 2013) . This method uses an extra variable, which is exogenous to the other variables in the model, but correlated with the independent variable. As the issuance of green bonds can be attributed to a wide variety of factors, a suitable instrumental variable is difficult to find. Instead, this study employs a matching methodology partly based on the research by Flammer (2021). This method creates a control group as similar as possible to the mergers by green bond firms, the treatment group, by looking at a variety of firm-level characteristics. First of all, mergers are matched on 2-digit SIC codes and countries. Furthermore, out of the remaining mergers, each treatment group merger is matched with a control group merger by calculating the Mahalanobis distance to find the nearest neighbor (Frésard & Valta, 2016). The distance is calculated over five different control variables: *Size, Cash holdings, Investment, Long Term Leverage* and *Tobin's Q*. Additionally, the delta of each of these variables further improves matching accuracy. This approach creates a similarly sized control and treatment group, which can be used for further analyses. The formal estimation of the Mahalanobis distance is depicted below.

$$\delta = [(X_i - X_j)^T \sum^{-1} (X_i - X_j)]^{1/2} \tag{1}$$

The distance between the treated firm i and the control firm j is calculated for each matching characteristic, after which a (10x10) covariance matrix of the matching characteristics determines the lowest Mahalanobis distance for the control sample. A risk inherent to this methodology is the possibility that several green bond mergers match the same control merger. To mitigate this risk, an additional statistical package is used to randomly select unique matches out of ten possible matches (Kantor, 2006). This ensures a larger treatment and control group, which improves accuracy of the analyses. The summary statistics of the treatment and control group are presented in table 4. The right column contains a difference in means test (two-sample t-test) to analyze the success of the matching procedure. The p-value indicates whether the h_0 hypothesis can be rejected in the difference in means test. At the 5% level, no h_0 hypotheses are rejected, confirming similarity between the two groups and therefore a proper basis for comparison

Table 4: Matched samples

Summary statistics

		N	Mean	Std. Dev.	Min	Max	P-value (difference in means)
Firm size	Green bond sample	598	11.2	2.16	4.56	13.4	0.12
	Control sample	597	10.9	2.01	4.36	13.4	
Cash holdings	Green bond sample	597	0.14	0.11	0.01	0.72	0.33
	Control sample	597	0.14	0.11	0.00	0.69	
Investment	Green bond sample	494	0.30	0.32	0.00	2.50	0.18
	Control sample	427	0.27	0.37	0.00	4.92	
Long Term Leverage	Green bond sample	357	0.23	0.16	0.00	0.63	0.76
	Control sample	426	0.18	0.16	0.00	0.90	
Tobin's Q	Green bond sample	324	1.07	0.251	0.78	3.21	0.19
	Control sample	284	1.09	0.409	0.65	3.78	
Δ Firm size	Green bond sample	488	0.16	0.25	-1.14	2.87	0.07
	Control sample	533	0.13	0.24	-0.57	3.01	
Δ Cash holdings	Green bond sample	488	-0.01	0.072	-0.32	0.32	0.96
	Control sample	533	-0.01	0.068	-0.25	0.41	
Δ Investment	Green bond sample	416	-0.03	0.27	-2.99	2.39	0.12
	Control sample	345	-2.02	25.9	-341	4.26	
Δ Long Term Leverage	Green bond sample	280	0.02	0.062	-0.16	0.55	0.54
	Control sample	354	-0.01	0.061	-0.34	0.26	
Δ Tobin's Q	Green bond sample	272	0.017	0.065	0.01	0.78	0.07
	Control sample	255	0.059	0.017	0.00	0.85	

This table presents the treatment (mergers by green bond firms) and control group (matched mergers by non-green bond firms. Mergers are matched by calculating the Mahalanobis distance over a set of control variables. The control variables are extracted from Compustat North-America and Compustat Global, for the year that the merger is announced. The p-value is calculated through a two-sample t-test, to verify mean similarity of the treatment and control group.

3.4 Limitations

The data set in this study is subject to various limitations. First of all, the analyses require data from various sources, which is limitedly available. Most statistical tests in this study require firm-level data, stock price data, merger data and a green bond to run the analysis. This decreases sample size substantially. Second of all, green bonds in general are a relatively new phenomenon in the fixed income market. As with any new development, data on long-term performance is limited. Furthermore, although the instrument has surged in popularity, green bonds still only account for around 4% of the worldwide bond market (The Economist, 2020). The Bloomberg green bond dataset is a comprehensive overview of issued bonds, but the firm-level data derived from Compustat is only available for a small portion of the dataset. The same limitation exists for stock price data from CRSP and Compustat. What remains is a relatively small sample size, which has implications regarding validity and robustness of the output.

4 Methodology

4.1 Short-term performance

4.1.1 Cumulative Abnormal Return

A first indicator of the effect of a firm's action is the reaction of the stock market. If the stock market reacts positively, one would expect to see abnormal returns surrounding the announcement date. Similarly, if the stock market approves of an impending merger, the stock prices surrounding the merger are expected to be abnormally positive. In this study, two types of events are analysed. First of all, the announcement of green bonds are considered. Second, I look at merger & acquisition announcements. The stock market's behaviour surrounding the announcement date of a green bond is a good indicator of the market's attitude. The rationale for incorporating mergers has been described in section 2.3 and is covered by Deng et al. (2013).

The general approach to calculating cumulative abnormal returns is similar for both green bonds and mergers & acquisitions. First, the event date needs to be determined. Besides the issue date, the Bloomberg dataset supplies an announce date on which the company has informed the public about the upcoming green bond issue. Similar data is supplied by ThomsonONE for merger announcements. As this would be the day that the information reaches the stock market, the event date is taken as the date of the announcement. However, in line with event study theory, it is assumed that information becomes known to the public several days prior to the official press release. (Krüger, 2015) Therefore, several event windows are considered. Furthermore, it is possible that there are periods of abnormal returns in the weeks prior to the event date, which will also be tested.

To determine the abnormality of returns, an estimation window of 200 days is taken, ending 10 days before the announcement. The abnormal returns are accumulated and regressed to find the correlation. The index of the country's main stock exchange is taken as a proxy for 'normal' returns. For each interval, this method is repeated. The choice of intervals is based on earlier research (Deng et al., 2013; Flammer, 2021). Returns are computed for firms individually using the market model. This is the most common approach in event studies and estimates an OLS regression using daily return data and market return data of the index on which a stock is traded. The formal estimation is depicted below.

$$R_{it} = \alpha_i + \beta_i * R_{mt} + \varepsilon_{it} \tag{2}$$

Subsequently, the estimated return on the stock of firm i on day t is calculated as follows:

$$\widehat{R}_{it} = \widehat{\alpha}_i + \widehat{\beta}_i * R_{mt} + \varepsilon_{it} \tag{3}$$

Finally, the abnormal return is given by:

$$AR_{it} = R_{it} - \widehat{R}_{it} \tag{4}$$

4.1.2 Green bonds

For green bonds, the cumulative abnormal returns are calculated surrounding the announcement date. This is the date that the information becomes public. The Bloomberg dataset documents the calendar date that the green bond is announced. If the stock market reacts consistently to the news of a green bond, this should be reflected in the CAR analyses with a statistically significant coefficient.

4.1.3 Merger subsamples

In section 3.2 the Mahalanobis approach is described as a tool to create a control group of non-green bond firm mergers that is as similar as possible to the treatment group. These sub-samples can be used to test differences in Cumulative Abnormal Returns surrounding merger announcement dates. The same methodology is applied in Deng et al. (2013), in which sub-samples of high and low CSR firms are compared based on abnormal returns surrounding merger announcement. To estimate abnormal returns, the same parameters are chosen as in the CARs for green bond announcement dates. An estimation window of 200 trading days ending 11 days before the event date and similar windows as in Deng et al. (2013). For the abnormal returns the stock price of the acquirer is used, as target stock prices often show abnormal returns in merger announcement (Huang & Walkling, 1987). Although a value-weighted portfolio of target and acquirer post-merger is considered the most reliable in corporate finance literature, many targets are not in the database, which limits this approach. If green bond firms perform better in mergers, they would be expected to show higher announcement returns surrounding the announcement dates.

4.2 Long-term performance

4.2.1 Cashflow

The two subsamples created with the matching methodology can be used to compare post-merger performance. In this case, the cash flow one year post-merger is used as a proxy for performance. By comparing the two subsamples, it is possible to distil the effects of a green bond 'treatment'. This can be assessed by OLS regression, in which the independent variable is the green bond treatment. The cash flow in the year post-merger functions as the dependent variable in the regression. *green bond* is a dummy variable which equals 1 if firm i has issued a green bond in the past. A green bond treatment is considered to enhance firm performance if the cash flow is higher post-merger, compared to non-green bond firms. A simplified mathematic equation of the model is depicted below.

$$Cashflow\ (t+1) = \alpha + \beta_1\ green\,bond\ (dummy) + Control\ variables + \varepsilon \tag{5}$$

4.2.2 Multi-factor models

An alternative measure of long term performance is stock price. As with financial performance of a firm, it is difficult to distil the effect of green bond issuance in stock returns. However, the long-term stock returns are less subject to the risk of reverse causality than financial performance or valuation. Furthermore, stock returns link more directly to shareholder value than financial performance. To compare performance of portfolios, managers often make use of asset pricing models. By determining a benchmark, the portfolio returns can be compared and its performance rated. If firms are performing better after issuing a green bond, a green bond firm portfolio would outperform the benchmark. Comparison to the benchmark ensures that any outperformance is not simply the result of taking risk.

To construct the portfolio, green bond firms are included after announcement of a green bond. In essence, all green bond firms are in the portfolio after issuance and remain in the portfolio until the final date of the sample. In the initial test, the portfolio is equal-weighted, meaning that the different stocks are not weighted to their value in relation to the portfolio value. As a robustness test, section 5.3.2 contains the value-weighted equivalent. Subsequently, excess-returns (returns in excess of the risk-free rate) are calculated using the risk-free data from the Kenneth R. French website. As this dataset is limited to the US, only US green bond firms are included for this part of the research. Several models are estimated, starting with the single-index model. This model is based on CAPM portfolio theory and is a relatively simple asset pricing model that captures broader market movements. (Sharpe, 1963).

$$R_{it} - R_f = \alpha + \beta_1 \left(R_m - R_f\right) + \varepsilon \tag{6}$$

The model is then extended with the size and book-to-market factors, following the theory of Fama & French (1993). Fama & French extended the single-factor model with other factors that were found to drive returns. For example, small firms may perform differently than large firms. The same can be said for high book-to-market or value firms in contrast to low book-to-market or growth firms. In a recession, small firms may be impacted more than large firms, while in periods of high growth, low book-to-market firms may outperform high book-to-market firms. The factors are estimated by taking the quintile of the smallest companies and subtracting the quintile of the largest companies. For book-to-market the same methodology is applied in which low book-to-market are subtracted from high book-to-market firms. The mathematical representation is depicted in equation 7.

$$R_{it} - R_f = \alpha_{it} + \beta_1 \left(R_m - R_f\right) + \beta_2\, SMB + \beta_3\, HML + \varepsilon \tag{7}$$

The fourth factor captures the momentum in the market (Carhart, 1997). The main assumption for this model is that momentum can influence a firm's performance on the stock market. Building on earlier literature, Carhart (1997) demonstrates that momentum in the market can explain part of the returns (Jegadeesh & Titman, 1993; Hendricks et al., 1993). In essence, the positive advancing firms are compared to the negative advancing firms. If the coefficient in the model shows a statistically significant correlation, this would indicate that the portfolio is sensitive to broader market momentum. The mathematical equation of the Carhart 4-factor model is depicted below.

$$R_{it} - R_f = \alpha_{it} + \beta_1(R_m - R_f) + \beta_2 SMB + \beta_3 HML + \beta_4 MOM + \varepsilon \tag{8}$$

The various models construct a benchmark for expected returns. This benchmark can then be used to compare the returns of a green bond firm portfolio. As with any portfolio, its performance is difficult to measure. Naturally, one can compare it to a suitable index, but that does generally not fully capture the difference in performance, as factors identified by Fama, French & Carhart also influence returns. When benchmarking historic returns, the risk should be offset by the returns. The multi-factor models generate a risk-adjusted benchmark and give insights into the sensitivity of a portfolio to the various factors. If firms that issue green bonds do perform better post-issuance, the green bond portfolio should outperform its benchmark over the sample period. The same methodology is applied by Edmans (2011) for the top 100 employers in the US, to determine their long-term difference in performance to the benchmark.

5 Results: green bonds

5.1 Short-term performance

The results are presented in table 5. The intuitive estimation windows used by Deng et al. (2013) do not produce a statistically significant coefficient. If the announcement of a green bond is truly news that influences the share price, these windows would best reflect the reaction of the stock market. The baseline windows [-5,10] used by Flammer (2021) aims to capture the effect of an earlier pre-announcement reaction and a delayed response. Other windows used in this study specifically focus on pre-announcement or post-announcement reactions. As shown in the bottom row of table 5 the [-10;-6] window shows a significant positive coefficient. The mean cumulative abnormal return is 0.0239%, which is quite small. However, this does indicate that there is a positive cumulative abnormal return in the period of 10 to 6 days before the announcement of the green bond issue.

These results do not fully support earlier research by Tang & Zhang (2020) and Flammer (2021), which both find positive announcement returns in the [-5,10] window. However, research on the well-known pecking order theory has shown that the stock market is usually negative on an equity issue and has no significant reaction on a bond issue. These earlier papers attribute the positive announcement returns on green bonds to a credible signal by companies to commit to the environment. This study finds a positive, but less prominent and premature reaction. If we assume that this can be attributed to the impending announcement of the green bond, it would mean that the market has access to the information before the actual announcement. Furthermore, it could be an indication that the surge in popularity of green bonds has led to a weakened response. In other words, the stock market is losing interest when novelty wears off. Ultimately, these conclusions cannot be formed based on these results alone and require further research. Based on these results it can be concluded with caution that the stock market reacts positively and prematurely to the announcement of a green bond in this sample. This confirms the first hypothesis. Section 5.3.1 provides further robustness tests.

Table 5: CAR: Green bond announcement date

Dependent variable: event window					
	CAR [-1;1]	CAR [-2;2]	CAR [-3;3]	CAR [-4;4]	CAR [-5;5]
Mean	-0.0226	-0.0351	-0.0494	-0.0661	-0.0681
(Standard error)	(0.0224)	(0.0358)	(0.0441)	(0.0573)	(0.0578)
Observations	612	612	612	612	612
	CAR [-5;10]	CAR [-10;-6]	CAR [-20;-11]	CAR [11;20]	CAR [21;60]
Mean	0.2400	0.0239**	0.0270	0.0818	0.4360
(Standard error)	(0.2430)	(0.0118)	(0.0245)	(0.0897)	(0.4500)
Observations	612	612	612	612	602

This table reports the average cumulative abnormal returns for the green bond announcement dates. Ten different event windows are tested, following research by Deng et al. (2013); Flammer (2021). Share price data is extracted from Compustat and CRSP. The returns indicate percentage returns on a daily basis. The parentheses contain robust standard errors. *, ** and *** denote significance at the 10%, 5% and 1% level, respectively.

5.2 Long-term performance

The results of the green bond portfolio factor models are presented in table 6. These portfolios are based on the green bond announcement date of the firm. First of all, it is apparent that the green bond firm portfolio generates excess returns over the benchmark. For the three different models, the alpha is between 0,0205 - 0,0353% above the risk-free rate. A green bond firm portfolio therefore outperforms the benchmark. However, the alpha is only statistically significant in the four factor model. The single-index model produces a significant positive coefficient that is almost 1. This means that the returns of the green bond portfolio closely follow the returns of the market. Extending the model with the size and book-to-market factors increases the R-squared slightly. Both the size factor and the book-to-market factor are statistically significant and have an effect on the model. The Small minus Big loading of -0.154 indicates that the portfolio is primarily large cap. This is in line with expectations, as it are mainly large firms that issue bonds in general and green bonds specifically. The High minus Low factor loading of 0.331 suggests that the portfolio consists predominantly of value stocks and less of growth stocks. The firms in the portfolio therefore have a relatively high book-to-market ratio.

When including the momentum factor, the coefficients remain relatively similar and the explanatory power of the model increases slightly. Remarkably, the alpha is significant in this model, which would indicate that the green bond portfolio generates excess risk-adjusted returns. The small but significant positive Momentum factor loading indicates that there is a small but significant sensitivity to broader market movements. The results in the Carhart 4-factor model support the stakeholder value maximization theory. Long-term performance of green bond firms outperforms the benchmark. Firms that exhibit socially responsible behaviour and value the interests of stakeholders, besides shareholders, perform better in the long run. Therefore, the Carhart 4-factor model confirms the second hypothesis. However, this implication must be interpreted with caution as the risk of endogeneity bias is still present. There may be some other distinctive characteristics for the sample of green bond firms. For instance, it may be the case that well-performing firms issue green bonds and therefore also perform better ex-post. As a robustness test, the next section covers the value-weighted green bond portfolio. To correct for endogeneity concerns, section 6 will cover green bond firms in relation to mergers.

Table 6: Green bond firm portfolio: equally-weighted

Multi-factor models

	Single-index	Fama-French 3-factor	Carhart 4-factor
β_{MKT}	0.967***	0.950***	0.949***
	(0.018)	(0.018)	(0.017)
β_{SMB}		-0.154***	-0.010***
		(0.034)	(0.035)
β_{HML}		0.331***	0.505***
		(0.025)	(0.035)
β_{MOM}			0.190***
			(0.026)
α	0.021	0.032	0.035*
	(0.021)	(0.020)	(0.019)
Observations	1,792	1,792	1,792
R-squared	0.612	0.649	0.659

This table presents the excess returns of a green bond firm portfolio based on three different factor models. The portfolio consists of green bond firms only. Firms are weighted equally and included in the portfolio from the announcement date of the green bond, until the end of the sample, march 2021. The share price data is extracted from Compustat North-America and CRSP. Factor loadings are taken from Kenneth R. French's website. The portfolio only contains firms based in the US. The parentheses contain robust standard errors. *, ** and *** denote significance at the 10%, 5% and 1% level, respectively.

5.3 Robustness

5.3.1 Green bond announcement returns

In this section, the robustness of results in section 5.1 is analyzed further. First of all, section 5.1.1 discussed the cumulative abnormal returns surrounding the green bond announcement date. This is the day that the pending issuance of a green bond by firm X becomes known to the market. When the market reacts positively to green bond announcements, one would expect a positive and statistically significant cumulative abnormal return. In table 5 it is shown that this result is only statistically significant in the [-10;-6] event window. This would indicate that the information is public before the announcement date. In this analysis, the market return is specific to a major stock index of the country in which the firm is based. To test the robustness of this earlier result, the same analysis is performed with the S&P 500 index as a proxy for market return. This index is US-based but widely regarded as an indicator of general market performance. The results are presented in table 7. When using the S&P 500 index, there is no statistically significant coefficient.

Table 7: CAR: Green bond announcement date (S&P 500)

	CAR event windows				
	(1) CAR [-5;10]	(2) CAR [-10;-6]	(3) CAR [-20;-11]	(4) CAR [11;20]	(5) CAR [21;60]
Mean	0.1730	0.0906	-0.0718	-0.0439	0.1640
(Standard error)	(0.1860)	(0.0963)	(0.0583)	(0.0339)	(0.1621)
	CAR [-1;1]	CAR [-2;2]	CAR [-3;3]	CAR [-4;4]	CAR [-5;5]
Mean	0.1010	0.0791	0.0634	0.0552	0.0387
(Standard error)	(0.1020)	(0.0835)	(0.0698)	(0.0553)	(0.0402)
Observations	612	612	612	612	612

This table reports the average cumulative abnormal returns for the green bond announcement dates, benchmarked against the S&P 500 world index. Merger data is extracted from Thomson One and share price data is extracted from Compustat and CRSP. The returns indicate percentage returns on a daily basis. The parentheses contain robust standard errors. *, ** and *** denote significance at the 10%, 5% and 1% level, respectively.

As the cumulative abnormal return was statistically significant with the country-specific index with event window [-10;-6], this event window is used for further robustness tests. These tests are presented in table 8. First of all, financial firms are excluded in model (1). This is common practice as a robustness check as financial firms often behave differently from the rest of the market (Eugene & French, 1992). Model (2) computes the CAR by excluding early years in the green bond dataset. The rationale behind this approach is the fact that green bonds experienced a surge in popularity in the years 2013-2015. The stock market may not have been aware of the potential value in these early years. In model (3) the CAR is computed by using the S&P 500 as a proxy for market return. In model (4) the S&P 500 composite index is used, which is value-weighted based on market cap. The various methods used to calculate the cumulative abnormal returns do not produce statistically significant coefficients.

Based on these analyses combined, it cannot be concluded with certainty that green bond issuers enjoy positive returns surrounding the announcement date. Furthermore, these results are not consistent with earlier findings on green bond announcement returns (Flammer, 2021; Tang & Zhang, 2020). Different findings may be explained by the more recent sample present in this study. It could be the case that the surge in green bonds has caused a decline in popularity on the stock market. Another explanation may lie in the sample size difference. The sample used by Flammer (2021) and Tang & Zhang (2020), consists of N=384 and N=132 issue-events respectively, while the sample in this study consists of N=612 observations, which is considerably larger. Finally, Tang & Zhang (2020) use different event and estimation windows to conduct their analysis. In conclusion, there is no fundamental support for the stakeholder value maximization view based on this event study on green bond announcement dates.

Table 8: CAR: Green bond announcement date (robustness)

CAR: alternative calculation

	CAR [-10;-6]	Standard error
(1) Exclude financials	-0.0103	0.0102
(2) Exclude green bonds <2014	0.0922	0.0982
(3) S&P 500 Composite index	0.0907	0.0964

This table reports additional CAR analyses with different parameters. (1) Excludes all firms that are classified as BICS level 1: Financials. (2) Excludes all green bonds that were announced prior to 2014. (3) S&P 500 Composite index as a benchmark for market return. *, **, and *** denote significance at the 10%, 5% and 1% level, respectively.

5.3.2 Green bond multi-factor models

The green bond multi-factor models in section 5.2 indicate that a portfolio constructed around green bond announcements can produce excess returns. The Carhart four-factor model, which includes the momentum factor, has a positive, statistically significant alpha. As a robustness check, a common method used is the construction of a value-weighted portfolio. In this portfolio, the positions are weighted on the relative market capitalization of the firm relative to the other firms in the portfolio. The results of the value-weighted portfolio are presented in table 9. First of all, it should be noted that the explanatory power is substantially lower compared to the equal-weighted portfolio. Second, the alpha is not statistically significant for any of the models, which means that there is no risk-adjusted excess return for this portfolio. Overall, the coefficients do not differ much from the equal-weighted portfolio. If a portfolio constructed around green bond announcement dates does in fact produce excess returns, this assumption is expected to hold when the portfolio is value-weighted. The result in the initial analysis is not robust to a different portfolio composition and the evidence on this hypothesis is therefore inconclusive. These findings do not support the stakeholder value maximization theory.

Table 9: Green bond firm portfolio: value-weighted

Multi-factor models			
	Single-index	Fama-French 3-factor	Carhart 4-factor
β_{MKT}	0.749***	0.756***	0.756***
	(0.020)	(0.021)	(0.021)
β_{SMB}		-0.119***	-0.110***
		(0.040)	(0.041)
β_{HML}		0.013	0.044
		(0.030)	(0.041)
β_{MOM}			0.034
			(0.031)
α	0.036	0.036	0.036
	(0.023)	(0.023)	(0.023)
Observations	1,792	1,792	1,792
R-squared	0.432	0.435	0.435

This table presents the excess-returns of a green bond firm portfolio based on three different factor models. The portfolio consists of green bond firms only. Firms are value-weighted based on market capitalization and included in the portfolio from the announcement date of the green bond, until the end of the sample, march 2021. The share price data is extracted from Compustat North-America and CRSP. Factor loadings are taken from Kenneth R. French's website. The portfolio only contains firms based in the US. The parentheses contain robust standard errors. *, ** and *** denote significance at the 10%, 5% and 1% level, respectively.

6 Results: mergers & acquisitions

6.1 Merger frequency

This section elaborates on the merger frequency of green bond firms compared to non-green bond firms. Comparison of merger frequency sheds light on potential differences of the two groups of firms in terms of merger behaviour. To compare the two groups, the full sample of approximately 142.000 mergers is used. For all the firms in the sample, the number of mergers per year is calculated. Figure 1 displays the average number of mergers per year, of the green bond firms and non-green bond firms respectively. For 2021, the merger count is lower as the data set only incorporates Q1 of 2021. It is clear that merger count per year differs for both groups. In almost all years, green bond firms merge more compared to non-green bond firms. This implicates that green bond firms differ from non-green bond firms in terms of merger rates. However, this cannot be concluded based on this analysis alone. It is plausible that increased merger frequency of green bond firms is not related to green bond issuance.

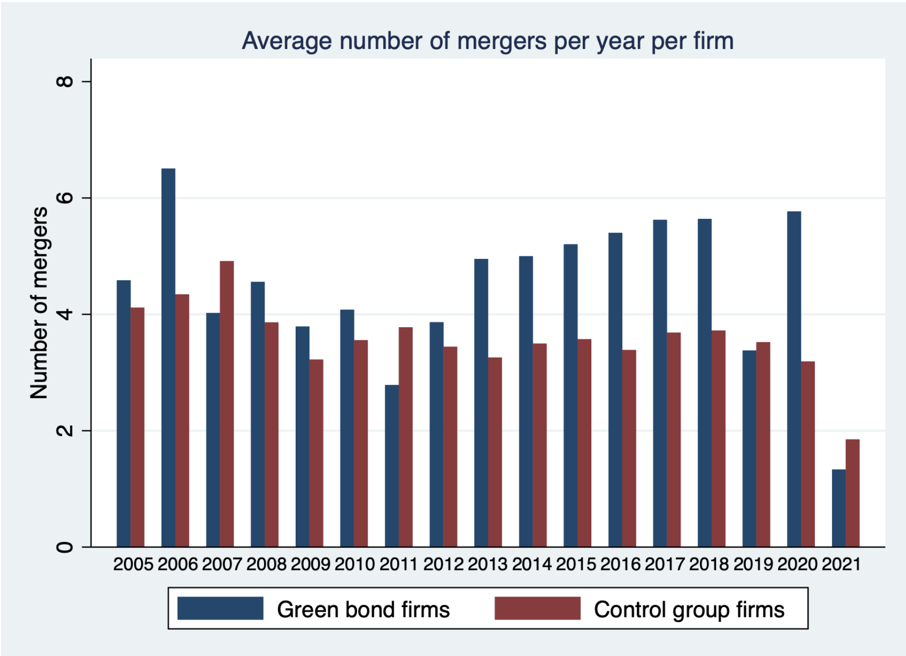

Figure 1: Average number of mergers per year

To extend the analysis, a difference-in-difference specification is used. In a difference-in-difference model, the differential effect of a 'treatment' is compared for a treatment and a control group. This methodology is employed when exchangeability between the treatment and control group cannot be assumed. In this case, the treatment is the issuance of a green bond. If a firm issues multiple green bonds, the first issue in the sample counts as the treatment day. For the control group, there is no specific treatment day as no green bond is issued. This issue is mitigated by using a data set of normal 'brown' bonds, extracted from Thomson ONE. This data set contains ordinary, non-convertible bonds. Each green bond firm is matched to several brown bond firms that have issued a bond in the same month.

Therefore each treatment date of the treatment group is matched to a treatment date for the control group in the same month. The treatment is therefore characterized by the 'greenness' of the bond. As all the green bond treatment dates are matched for the control group, the time variance of merger frequency is captured in the model. In this analysis, the time-frame is limited to 2020 to include only full years. The mathematical expression is depicted below.

$$y = \alpha_i + \alpha_c + \beta_1 D^{post} + \beta_2 D^{green\,bond} + \beta_3 D^{post} D^{green\,bond} + \varepsilon \tag{9}$$

In this expression y is the outcome variable, which is merger frequency on a yearly basis. α_i are firm fixed effects and α_s are industry fixed effects. D^{post} is the dummy variable for the treatment date. This variable equals one if the merger takes place after the (green) bond issuance. $D^{green\,bond}$ is the dummy variable that equals one if the firm has issued a green bond at one point in time. Finally, B_3 is the coefficient of interest, which captures the average treatment effect between treated and control firms. In other words, B_3 measures the change in merger frequency following the green bond issue, while taking into account the change in merger frequency for brown bond firms within the same period.

This approach allows to properly compare the causal relation of green bond issuance and subsequent merger frequency. More specifically, it estimates the effect of a green treatment on merger frequency. Merger frequency is calculated per firm per year. As firm homogeneity cannot be assumed, firm-level fixed effects are added to control for differences between firms. Green bond firms could be inherently different in terms of merger frequency than other firms. As mergers also cluster in specific industries, this element is controlled for by using industry-level fixed effects at the 2-digit SIC level. Adding industry-level fixed effects to the regression aims to correct for differences in merger frequency between industries. The results are presented in table 10. The statistically significant positive coefficient implicates that green bond firms show increased merger frequency post-bond issuance, compared to other firms that issue a brown bond in a similar month. Post-issuance, merger frequency increases by 1.112 mergers per year. As the average merger rate per year is around 5 mergers, this increase is not substantial. Nonetheless, this indicates that the 'greenness' of the bond is related to a higher merger frequency post-issuance. Furthermore, the regression indicates that merger rates in general decrease post-issuance with 1.122 mergers per yeaar. This is also visible in figure 1, which shows that merger rates by control group firms are higher in early sample years, while green bond firms show increased merger frequency. As the green bond firm coefficient is not significant, its value cannot be interpreted.

Finally, it must be noted that the time span of the sample is relatively short (16 years). To fully understand how merger waves affect merger behaviour by green bond firms, a longer time frame is required. As green bonds only recently came into existence, behaviour in the long term remains a subject for future research.

Table 10: Difference-in-difference: merger frequency

Dependent variable: mergers per year		
Post-issuance	-1.122***	(0.103)
Green bond firm	0.969	(4.041)
Green bond * Post-issuance	1.112***	(0.366)
Firm-level fixed effects	Yes	
Industry-level fixed effects	Yes	
Observations	10,172	
R-squared	0.59	

This table reports the mergers per day (post-issuance) of green bond firms. The coefficient is the increase in the number of mergers per day in the period following a green bond issue for green bond firms. The parentheses contain robust standard errors. *, ** and *** denote significance at the 10%, 5% and 1% level, respectively.

6.2 Short-term performance

6.2.1 Merger announcement returns

In this section, I look at cumulative abnormal returns surrounding merger announcement dates of green bond firms and similar, matched non-green bond firms. As mentioned before, the share price of the acquirer is used as proxy for performance. To compare the performance surrounding the merger announcement, the CAR analyses are run separately for each sample on five different event windows. The results for the three different samples are presented in table 11. The cumulative returns are plotted in figure 2. For the five event windows, all the coefficients are positive. However, only the CAR (-3, 3), (-4, 4) and (-5,5) show a statistically positive coefficient. For these event windows, there is a positive cumulative abnormal return. These findings are in line with the research on merger performance for firms with high and low CSR spending, meaning that the two groups behave differently in terms of announcement returns (Deng et al., 2013). This difference is visualised in the plot in figure 2. The cumulative returns are higher for mergers by green bond firms. However, for the acquirer CARs Deng et al. (2013) find that low CSR firms perform worse in mergers, but no statistically significant relation for high CSR firms. In this study, the green bond firms show significant positive announcement returns, but no relation is found for the matched control group.

Although CSR spending and green bond issuance are not perfect substitutes, earlier research has established the link between environmental responsibility and stock market performance (Flammer, 2015; Edmans, 2011). The same relationship is found in this study. However, it is possible that the positive announcement returns are subject to endogeneity bias. The focus on mergers, combined with the matching methodology of the control group corrects for this risk. Furthermore, it must be noted that the number of observations for the control group is substantially lower, due to limited availability of data for the matched mergers. In conclusion, the positive announcement returns indicate better performance for green bond firms post-merger and support the stakeholder value maximization view (Deng et al., 2013). Firms that maximize stakeholder value ultimately contribute to shareholder wealth. The results in the control group lead to the same conclusion. There are no positive announcement returns for mergers by firms that have not issued a green bond in the past.

Table 11: CAR: merger samples

	Dependent variable: CAR event windows				
	CAR [-1;1]	CAR [-2;2]	CAR [-3;3]	CAR [-4;4]	CAR [-5;5]
	Green bond firms				
Mean	0.152	0.170	0.402*	0.643**	0.572*
(Standard error)	(0.124)	(0.167)	(0.241)	(0.270)	(0.307)
Observations	447	447	447	447	447
	Control group firms				
Mean	0.007	0.018	0.053	0.198	0.193
(Standard error)	(0.047)	(0.061)	(0.077)	(0.141)	(0.147)
Observations	201	201	201	201	201
	Full sample				
Mean	0.107	0.123	0.294	0.505	0.454
(Standard error)	(0.101)	(0.144)	(0.153)	(0.172)	(0.175)
Observations	648	648	648	648	648

This table reports the average cumulative abnormal returns for the merger announcement dates of green bond firms, control group firms and the full sample. green bond firms have issued a green bond in the past. Control group firms are mergers that are matched to the treatment group by calculating the Mahalanobis distance over a set of control variables. The full sample combines the green bond firms and control group firms. Merger data is extracted from Thomson One and share price data is extracted from Compustat and CRSP. The returns indicate percentage returns on a daily basis. The parentheses contain robust standard errors. *, ** and *** denote significance at the 10%, 5% and 1% level, respectively.

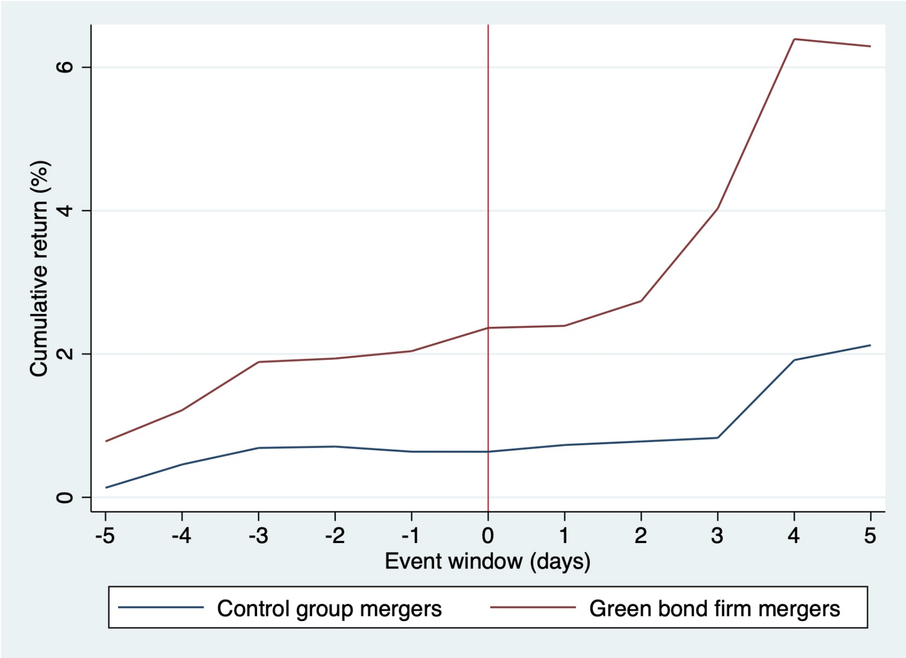

Figure 2: Cumulative returns of merger announcements by green bond and control firms

6.2.2 Cross-sectional regression

To better understand the variation within the CAR sample, a cross-sectional regression is performed, as described by (Deng et al., 2013). For this analysis, CAR estimates of the green bond firm subsample and the control firm subsample are combined. In the regressions, the dependent variable is the CAR estimate of the 5 windows used by Deng et al. (2013). The independent variable is the green bond dummy. To control for differences between firms, the control variables used in this study are added in two parts. Per event window, the first regression is without and the second regression is with the delta variables. The delta variables control for changes from t-2 to t-1, which may impact the cumulative abnormal returns. The results are presented in table 12. First of all, it must be noted that the R-squared for these models is very low. This limits the interpretation of the coefficients. However, it is clear that the statistically significant relation in the (-3;3), (-4;4) and (-5;5) event windows do not hold when controlling for firm-level differences. A cross-sectional regression analysis of the positive announcement returns found in section 6.2.1 does not find the same relation. Overall, this robustness test fails to produce similar results as in section 6.2.1. Although the positive announcement returns indicate increased short-term merger performance, when firms have issued a green bond, the cross-sectional analysis disputes this. These results combined reject the third hypothesis. Furthermore, these analyses contradict earlier findings by Deng et al. (2013) and Flammer (2021). As mentioned earlier, this study differentiates on a larger sample size and a more recent sample. However, the merger control group is relatively small. Especially for the cross-sectional analysis, data is limited for the control variables.

Table 12: Cross-sectional CAR analysis

	Dependent variable: CAR event window									
	CAR [-1;1]	CAR [-1;1]	CAR [-2;2]	CAR [-2;2]	CAR [-3;3]	CAR [-3;3]	CAR [-4;4]	CAR [-4;4]	CAR [-5;5]	CAR [-5;5]
Green bond (dummy)	-0.001	0.001	-0.004	0.000	-0.002	0.001	-0.002	0.001	-0.002	0.001
	(0.003)	(0.003)	(0.005)	(0.003)	(0.005)	(0.004)	(0.005)	(0.004)	(0.005)	(0.005)
Firm size	0.000	0.000	0.000	-0.001	-0.000	-0.001	0.000	-0.001	0.000	-0.002
	(0.001)	(0.001)	(0.002)	(0.001)	(0.002)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)
Cash holdings	-0.004	0.016	-0.005	0.019	-0.000	0.026	-0.005	0.035	0.002	0.042
	(0.018)	(0.015)	(0.027)	(0.018)	(0.027)	(0.022)	(0.026)	(0.025)	(0.027)	(0.027)
Investment	0.001	0.003	-0.005	-0.000	0.000	0.003	0.001	0.007	0.000	0.005
	(0.007)	(0.007)	(0.011)	(0.009)	(0.011)	(0.011)	(0.010)	(0.012)	(0.011)	(0.013)
Long Term Leverage	-0.012	-0.009	-0.017	-0.004	-0.013	-0.005	-0.016	-0.009	-0.016	-0.007
	(0.011)	(0.009)	(0.017)	(0.010)	(0.016)	(0.012)	(0.016)	(0.014)	(0.017)	(0.015)
Tobin's Q	-0.000	-0.000	-0.000	0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Δ Firm size		-0.006		-0.005		-0.005		-0.003		-0.006
		(0.007)		(0.009)		(0.011)		(0.012)		(0.013)
Δ Cash holdings		0.006		0.020		0.025		0.020		0.024
		(0.017)		(0.021)		(0.024)		(0.028)		(0.030)
Δ Investment		-0.003		-0.001		-0.002		-0.002		0.001
		(0.004)		(0.005)		(0.006)		(0.007)		(0.008)
Δ Long Term Leverage		0.005		-0.003		-0.002		-0.008		-0.002
		(0.026)		(0.032)		(0.038)		(0.044)		(0.047)
Δ Tobin's Q		0.000		-0.000		-0.000		0.000		-0.000
		(0.000)		(0.000)		(0.000)		(0.000)		(0.000)
Constant	0.003	-0.002	0.009	0.004	0.012	0.005	0.006	0.009	0.003	0.011
	(0.013)	(0.010)	(0.019)	(0.013)	(0.019)	(0.015)	(0.019)	(0.017)	(0.019)	(0.018)
Observations	294	224	294	224	294	224	294	224	294	224
R-squared	0.008	0.027	0.009	0.017	0.006	0.018	0.008	0.021	0.007	0.022

This table reports cross-sectional regressions of cumulative abnormal returns, following a merger by green bond firms or similar, matched non-green bond firms. The dependent variables are the different event windows, while the green bond dummy is the explanatory variable. The parentheses contain robust standard errors.

6.3 Long-term performance

6.3.1 Cashflow post-issuance

The results of the regression are presented in table 13. The regression is run in three different compositions, with two levels of control variables. In column 1 it is shown that a green bond 'treatment' for a non-green bond firm would increase cashflow post-issuance with 0.399, significant at the 1% level. Although the coefficient decreases when control variables are included, the significant relationship remains. This indicates that firms that issue green bonds have higher cash flow in the year post-issuance. However, it must be noted that the R-squared is very low for the first model. The control variables control for differences between firms that may affect the relation between the green bond issuance and the higher cashflow post-merger. The explanatory power of the model increases significantly when adding the control variables. The significant relation between a green bond 'treatment' and cash flow the year post-issuance remains intact. Due to limited availability of firm-level data, including all control variables decreases the number of observations to about a quarter of the initial sample.

The higher cash flow post-merger is an indication that the stakeholder value maximization theory also applies in the long-run. Firms that operate environmentally responsible, by issuing a green bond, perform better in the year post-merger. However, despite the matching methodology and the random aspect of mergers, endogeneity concerns still exist. First of all, omitted variable bias could be present. There may be a variable missing that influences the relation. Second of all, there is a possibility for reverse causality, for instance when well-performing firms perform better post-merger, and issue green bonds. To better understand the relationship between green bonds and mergers, one could take a shorter time-span between the issuance of the green bond and the announcement of the merger. However, this approach was not feasible in this study, due to limited data. In conclusion, the analysis shows that green bond firms perform better one year post-merger, based on cash flow, than non-green bond firms. This finding confirms the fourth hypothesis and is in favour of the stakeholder value maximization view. Section 6.4.3 contains a robustness test for this analysis. The next section contains further long-term performance analyses.

Table 13: Cashflow post-merger

Dependent variable: cashflow (t+1)			
	(1)	(2)	(3)
Green bond (dummy)	0.399***	0.198***	0.072**
	(0.134)	(0.035)	(0.036)
Firm size		-0.004	0.028*
		(0.015)	(0.015)
Cash holdings		0.919***	-0.037
		(0.144)	(0.137)
Investment		0.364***	0.484***
		(0.085)	(0.097)
Long Term Leverage		-0.600***	-0.385***
		(0.131)	(0.127)
Tobin's Q		0.000***	0.000**
		(0.000)	(0.000)
Δ Firm size			0.112
			(0.123)
Δ Cash holdings			-0.169
			(0.248)
Δ Investment			0.031
			(0.025)
Δ Long Term Leverage			-0.130
			(0.321)
Δ Tobin's Q			0.000***
			(0.000)
Constant	-0.072	0.097	-0.137
	(0.094)	(0.176)	(0.177)
Observations	1,012	369	268
R-squared	0.009	0.415	0.510

This table reports the cash flow in the year post-merger. The green bond dummy variable indicates whether the firm has issued a green bond in the past. The control variables are extracted from Compustat North-America and Compustat Global and contain firm-level financial data in the year of the merger (t+0). The parentheses contain robust standard errors. *, ** and *** denote significance at the 10%, 5% and 1% level, respectively.

6.3.2 Merger multi-factor models

The results of the multi-factor models of the merger and control subsamples are presented in table 14. This analysis gives insight into the performance of a portfolio of mergers by green bond firms compared to mergers by similar, non-green bond firms. Three different portfolios are analyzed per subgroup. The difference between these portfolios is the number of years merged firms are kept in the portfolio after they have been announced. First, the green bond portfolio is discussed. The portfolio has a positive and statistically significant alpha, which holds across all models. This would indicate that the green bond portfolio has excess returns above the market.

The single-index model has a relatively similar coefficient across all models, which is approximately 0.6. This means that the returns of the portfolio do not closely follow the returns of the market. The alpha is statistically significant and positive. However, the statistically significant coefficients in other models indicate that the single-index model does not cover all factors. Adding the Small minus Big factor yields a negative coefficient of approximately -0.18. This coefficient is significant at the 1% level. This is an indication that the green bond portfolio is primarily large-cap, which is expected given the fact that primarily large firms issue green bonds. This finding is similar to the results in 5.2. The coefficient of the High minus Low factor fluctuates between 0.24 - 0.30 and suggests that the green bond portfolios predominantly consist of value stocks. Again, this result is in line with earlier findings. Furthermore, the coefficient for the Momentum factor is statistically significant in all three portfolios. Remarkably, the coefficient is negative, which means there is a negative reaction to broader market movements. This result contradicts earlier findings for the green bond portfolio in 5.2. However, it must be noted that the coefficient is very small (0.04 - 0.05).

The results of the control group mergers indicate that there are differences between the two portfolio groups. The key indicator is the alpha, which is not statistically significant in the majority of the models. The significant alphas in the 3-year portfolio are very small compared to the alphas in the green bond portfolios. Excess returns over the market in the control group portfolios are therefore not statistically significant or significantly smaller than the excess returns in the green bond portfolio. When looking at the different factor loadings, only the statistically significant results can be interpreted properly. First of all, the market factor loading is relatively similar across the regressions. However, it is lower than the average coefficient of the green bond portfolios, meaning that the correlation with the market's returns is lower for the control group. The Small minus Big factor reveals another difference. As the coefficient is positive, this indicates that the control group portfolios are also large-cap, but less distinctively so. The High minus Low factors are only significant in regression 2 and 8 and should therefore be interpreted with caution. However, the small but positive coefficient suggests that the portfolios consist predominantly of value stocks and less of growth stocks. The momentum factor is very small and only significant for the 1-year portfolio and can therefore not be interpreted with confidence. In general, it should be noted that the explanatory power in the control group mergers is substantially lower than in the models of the green bond portfolios.

From this analysis, the following can be concluded. First of all, a portfolio comprised of green bond firm mergers has statistically significant excess returns. Second, these excess returns hold when extending the duration that firms are kept in the portfolio post-merger. This result suggests that green bond firms perform better in the long-run, following a merger, than non-green bond firms. This confirms the fourth hypothesis. It could be the case that the stock market favours 'green' companies. On the other hand, post-merger performance of non-green bond firms is ambiguous. The results of the control group mergers have to be interpreted with caution, as the explanatory power and statistical significance are less clear. This result supports the stakeholder value maximization theory. Environmentally responsible firms perform better post-merger and a portfolio constructed around mergers of green bond firms produces excess returns. It must be noted that endogeneity concerns still exist. As mentioned before, excess returns can be the result of differences between the two groups besides green bond issuance. Furthermore, limited availability of data has reduced the sample size.

Table 14: Merger portfolio: equally-weighted

	Green bond mergers								
	1 year			2 year			3 year		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Model	CAPM	3 Factor	4 Factor	CAPM	3 Factor	4 Factor	CAPM	3 Factor	4 Factor
β_{MKT}	0.645***	0.604***	0.602***	0.623***	0.579***	0.575***	0.605***	0.566***	0.563***
	(0.010)	(0.010)	(0.010)	(0.009)	(0.010)	(0.009)	(0.009)	(0.010)	(0.010)
β_{SMB}		-0.181***	-0.182***		-0.178***	-0.180***		-0.167***	-0.168***
		(0.019)	(0.019)		(0.019)	(0.019)		(0.018)	(0.018)
β_{HML}		0.292***	0.260***		0.309***	0.260***		0.276***	0.237***
		(0.015)	(0.020)		(0.015)	(0.019)		(0.015)	(0.019)
β_{MOM}			-0.036**			-0.056***			-0.044***
			(0.014)			(0.014)			(0.013)
α	0.120***	0.126***	0.125***	0.135***	0.140***	0.140***	0.145***	0.150***	0.150***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.011)	(0.011)	(0.012)	(0.011)	(0.011)
R^2	0.547	0.597	0.598	0.541	0.599	0.601	0.540	0.590	0.591
	Control group mergers								
	1 year			2 year			3 year		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
β_{MKT}	0.440***	0.439***	0.441***	0.433***	0.425***	0.426***	0.435***	0.423***	0.422***
	(0.010)	(0.010)	(0.010)	(0.008)	(0.009)	(0.009)	(0.008)	(0.008)	(0.008)
β_{SMB}		0.090***	0.090***		0.086***	0.086***		0.093***	0.093***
		(0.020)	(0.020)		(0.017)	(0.017)		(0.016)	(0.016)
β_{HML}		-0.029*	-0.008		0.010	0.010		0.031**	0.021
		(0.016)	(0.020)		(0.014)	(0.017)		(0.013)	(0.016)
β_{MOM}			0.025*			0.001			-0.013
			(0.015)			(0.012)			(0.012)
α	-0.008	-0.090	-0.009	-0.004	-0.004	-0.004	0.017*	0.018*	0.018*
	(0.012)	(0.012)	(0.012)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)	(0.010)
R^2	0.352	0.356	0.357	0.423	0.426	0.426	0.449	0.454	0.454

This table presents the excess returns of a merged firm portfolio based on three different factor models. The portfolio consists of either green bond firms or non-green bond firms only. Firms are weighted equally and included in the portfolio from the announcement date of the merger, until the end of the sample, march 2021. The share price data is extracted from Compustat North-America and CRSP. Factor loadings are taken from Kenneth R. French's website. The portfolio only contains firms based in the US. The returns indicate percentage returns on a daily basis. The parentheses contain robust standard errors. *, ** and *** denote significance at the 10%, 5% and 1% level, respectively.

6.4 Robustness

6.4.1 Merger announcement returns

Section 6.2.1 analyses the cumulative abnormal returns surrounding announcement dates of mergers by green bond firms, versus those of similar (matched) non-green bond firms. Table 11 shows that the green bond firm sub-sample has statistically significant, positive announcement returns in the (-3;3), (-4;4) and (-5;5) event windows. This is an indication that green bond firms enjoy a positive reaction of the stock market when announcing a merger. Furthermore, results suggest that the control group of non-green bond firms does not. However, this result alone is not enough to conclude with confidence that this relation has external validity. First of all, this result is tested for robustness by using the S&P 500 as a proxy for market return, instead of country-specific indices. The results are presented in table 15. The statistically significant relation does not hold when the index is replaced, which makes the evidence for this hypothesis inconclusive. Although country-specific indices are a better proxy for market returns in this analysis, one would expect the positive announcement returns to hold when using a broader market index like the S&P 500 to assume external validity of the result.

Table 15: CAR: merger samples (S&P 500)

Dependent variable: CAR event window					
	CAR [-1;1]	CAR [-2;2]	CAR [-3;3]	CAR [-4;4]	CAR [-5;5]
Mean	0.0697	0.0890	0.1540	0.2110	0.0605
(Standard error)	(0.1260)	(0.1670)	(0.1930)	(0.2270)	(0.2310)
Observations	447	447	447	446	446

This table reports the average cumulative abnormal returns for the merger announcement dates of green bond firms, benchmarked against the S&P 500 world index. Merger data is extracted from Thomson One and share price data is extracted from Compustat and CRSP. The returns indicate percentage returns on a daily basis. The parentheses contain robust standard errors. *, ** and *** denote significance at the 10%, 5% and 1% level, respectively.

6.4.2 Cross-sectional regression

This section contains a robustness test for the cross-sectional regression, performed in section 6.2.2. A similar regression is performed, with the addition of fixed effects. The regressions are estimated with year and firm fixed effects by adding dummy variables for each year and each firm in the sample. This further controls for time variance and differences between firms. It could be the case that differences between years have a significant effect on the relationship between the green bond dummy and the cumulative abnormal returns. The same principal applies to firms. Adding fixed effects corrects for this possibility. The results are presented in table 16. Although the R-squared is higher compared to the results in table 12, this is expected as fixed effects increase the number of coefficients. As with the initial analysis, there is no statistically significant relation when controlling for firm-level variation. The third hypothesis remains rejected.

Table 16: Cross-sectional CAR analysis

Dependent variable: CAR event window										
	CAR [-1;1]	CAR [-1;1]	CAR [-2;2]	CAR [-2;2]	CAR [-3;3]	CAR [-3;3]	CAR [-4;4]	CAR [-4;4]	CAR [-5;5]	CAR [-5;5]
Green bond (dummy)	-0.007	-0.018	0.003	-0.024	-0.002	-0.028	-0.002	-0.024	-0.001	-0.024
	(0.032)	(0.037)	(0.039)	(0.045)	(0.005)	(0.053)	(0.005)	(0.058)	(0.005)	(0.064)
Firm size	-0.006	-0.009	-0.002	-0.010	-0.000	-0.013	0.000	-0.011	0.001	-0.009
	(0.007)	(0.012)	(0.008)	(0.014)	(0.002)	(0.017)	(0.002)	(0.018)	(0.002)	(0.020)
Cash holdings	0.000	0.031	0.017	0.032	-0.000	0.047	-0.005	0.071	0.031	0.102
	(0.030)	(0.045)	(0.037)	(0.055)	(0.027)	(0.065)	(0.026)	(0.072)	(0.003)	(0.079)
Investment	-0.013	-0.012	-0.010	-0.022	0.000	-0.016	0.001	-0.024	-0.004	-0.031
	(0.013)	(0.024)	(0.016)	(0.030)	(0.012)	(0.035)	(0.010)	(0.038)	(0.012)	(0.042)
Long Term Leverage	0.005	-0.007	-0.018	-0.006	-0.0130	0.008	-0.017	-0.003	-0.011	-0.003
	(0.027)	(0.043)	(0.033)	(0.053)	(0.016)	(0.062)	(0.016)	(0.069)	(0.018)	(0.075)
Tobin's Q	-0.000	0.000	-0.000	-0.000	-0.000	-0.000	-0.000	-0.000	0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Δ Firm size		-0.012		-0.016		-0.009		-0.005		-0.009
		(0.024)		(0.029)		(0.035)		(0.038)		(0.042)
Δ Cash holdings		0.001		0.031		0.037		0.034		0.051
		(0.034)		(0.042)		(0.050)		(0.055)		(0.060)
Δ Investment		-0.001		0.003		0.002		0.004		0.010
		(0.010)		(0.012)		(0.015)		(0.016)		(0.018)
Δ Long Term Leverage		0.016		0.013		0.012		0.010		-0.002
		(0.054)		(0.067)		(0.079)		(0.087)		(0.095)
Δ Tobin's Q		0.000		0.000		0.000		0.000		0.000
		(0.000)		(0.000)		(0.000)		(0.000)		(0.000)
Constant	0.089	0.070	0.023	0.070	0.012	0.089	0.006	0.066	-0.013	0.050
	(0.097)	(0.090)	(0.117)	(0.111)	(0.019)	(0.131)	(0.019)	(0.144)	(0.044)	(0.158)
Firm fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	294	224	294	224	294	224	294	224	294	224
R-squared	0.544	0.103	0.704	0.087	0.006	0.097	0.008	0.153	0.073	0.136

This table reports cross-sectional regressions of cumulative abnormal returns, following a merger by green bond firms or similar, matched non-green bond firms. The regression contains firm-level and year fixed effects. The dependent variables are the different event windows, while the green bond dummy is the explanatory variable. The parentheses contain robust standard errors.

6.4.3 Cashflow post-issuance

As with most empirical analyses, there is the risk of misspecification of the model and omitted variable bias. This is also the case in the long-term performance analysis of a green bond firm portfolio. Given the fact that overall sample size is relatively small, it would be difficult to conclude with certainty that the sample is random. It could be the case that data on green bonds is only available for larger, established firms. Furthermore, as green bonds have been around for over a decade, the differences between years can play a role as well. Especially with corporate efforts towards sustainability, one must take into account the changing market conditions. Around 2007, when the first recognized green bond was issued, there was undoubtedly less attention to sustainability in general. Several years later, the data shows that green bonds have become much more popular. Intuitively, it would be expected that the announcement of a green bond in 2009 is received differently by the market than in 2018. Therefore, a robustness test for this model adds year fixed effects. In essence, this approach adds a dummy variable for every year in the data set, to control for differences between years. As with years, the same rationale can be applied for firm differences. For instance, it may be the case that some firms often experience different market reactions than others. Although the matching methodology attempts to eliminate firm differences between the control and treatment group, this does not guarantee that there are none. Furthermore, there could be significant differences between firms within the green bond sample as well. Considering the many factors that affect firm performance and therefore operating cash flow post-merger, firm heterogeneity is a legitimate concern. Therefore, this robustness test also included firm fixed effects. The results of the regression including fixed effects are presented in table 17.

The statistically significant relation remains intact when including fixed effects. The coefficient in the third model is significantly higher and the R-squared is very high. However, it must be noted that the explanatory power of the model tends to be overestimated, as a large range of control variables is added to the model. The findings are in line with previous long-term analyses and indicate a higher performance for green bond firms post-merger. Again, these findings confirm the fourth hypothesis.

Table 17: Cashflow post-merger: robustness

Dependent variable: cashflow (t+1)			
	(1)	(2)	(3)
GB firm (dummy)	0.073	0.298***	0.821***
	(1.402)	(0.110)	(0.119)
Firm size		-0.274***	-0.200***
		(0.045)	(0.035)
Cash holdings		-0.538***	-0.332***
		(0.162)	(0.115)
Investment		-0.032	0.341***
		(0.066)	(0.075)
Long Term Leverage		-0.128	-0.096
		(0.128)	(0.118)
Tobin's Q		-0.000	-0.000***
		(0.000)	(0.000)
Δ Firm size			-0.171**
			(0.072)
Δ Cash holdings			0.173*
			(0.093)
Δ Investment			-0.099***
			(0.024)
Δ Long Term Leverage			-0.698***
			(0.141)
Δ Tobin's Q			-0.000**
			(0.000)
Constant	0.069	4.501***	2.169***
	(1.132)	(0.513)	(0.370)
Firm fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Observations	1,012	369	268
R-squared	0.778	0.956	0.980

This table reports the cash flow in the year post-merger. The regressions include firm and year fixed effects, which add dummies for each year and firm in the regression. The green bond dummy variable indicates whether the firm has issued a green bond in the past. The control variables are extracted from Compustat North-America and Compustat Global and contain firm-level financial data in the year of the merger (t+0). The parentheses contain robust standard errors. *, ** and *** denote significance at the 10%, 5% and 1% level, respectively.

7 Conclusion

This study offers a new perspective on the rapidly increasing popularity of green bonds, a fixed-income instrument used to raise capital for environmentally responsible projects. The main goal of this research is to analyze performance of firms that issue green bonds, upon issuance and in relation to mergers & acquisitions. The literature has established various motives for issuing a green bond. Concerns regarding validity of the environmental commitment (greenwashing) and the motive of obtaining cheap financing (green premium) have been addressed in earlier research (Deng et al., 2013; Flammer, 2021; Tang & Zhang, 2020). There is no substantial evidence for false motives by companies that issue green bonds. Companies that issue green bonds are found to reduce carbon emissions post-issuance (Flammer, 2021). The evidence is mixed for the cost of capital argument. Earlier research finds discounts for green bonds, but Larcker & Watts (2020) revisit these findings and argue that the evidence for a green bond premium is the result of methodological misspecifications. Their study employs a matching methodology and finds no evidence of a premium on green bonds. A subsequent study by Flammer (2021) corroborates these findings.

At this stage, various authors have reached consensus on the rationale for issuing green bonds. First of all, companies are thought to seek increased investor attention. Second, by issuing a green bond companies aim to signal the market regarding their credible commitment to the environment (Flammer, 2021; Tang & Zhang, 2020). As the motives for issuing green bonds are valid and legitimate, it is probable that green bonds survive the hype phase and will become permanent in the corporate sector. This underlines the importance of gaining insight into the relation between green bonds and subsequent firm performance. Furthermore, the short-term and long-term performance are analyzed in the context of mergers.

This study has analysed both short- and long-term performance post-issuance of firms that issue green bonds. The event study approach yields positive returns for green bond announcements, as well as merger announcements by green bond firms. A Mahalanobis distance matching approach generates a control group of mergers by similar, non-green bond firms. The control group yields no positive announcement returns. Although these results indicate a short-term advantage for green bond firms, the relation does not hold when conducting various robustness tests. Various multi-factor models and comparison of cash flow post-issuance of the treatment and control group give insight into the long-term performance. An equally-weighted portfolio constructed of green bond firms produces excess returns. However, a value-weighted portfolio does not. For the matched merger samples, cash flow post-issuance is higher for green bond firms in the year post-merger. This result is robust to the inclusion of firm and year fixed effects.

Overall, evidence on a green bond advantage is ambiguous. Although most analyses indicate an increased performance by green bond firms, robustness tests often yield different results. This partly contradicts earlier studies that show positive announcement returns of green bonds (Flammer, 2021; Tang & Zhang, 2020). This difference may be explained by the larger and more recent data set of green bonds. As popularity of the sustainable debt instrument increases, its effect on firm performance may decrease. Furthermore, this study finds some evidence for the effect of a green bond issue on long-term merger performance. The outcome of the long-term analysis is similar to the findings by Deng et al. (2013) on CSR and merger performance. However, further robustness tests contradict some of these findings. The evidence is in favour of the stakeholder value maximization theory, which predicts socially responsible firms to outperform firms that act purely in the interest of shareholders. That being said, these results are not sufficient to interpret the magnitude of the relationship with confidence. The definitive implication for firms that issue green bonds remains unclear.

7.1 Limitations and future research

This study is subject to a number of limitations. First of all, data availability is limited. Although Bloomberg offers an extensive data set on issued green bonds, in most cases there is no firm-level and share price data available. This decreases sample size and may cause sample selection bias, as only larger or well-documented firms are available for analysis. The scarce data has limited further testing of subsamples and the selection of various characteristics to build a representative sample. Furthermore, green bonds are relatively new and immature as a fixed income product. Its long-term development remains uncertain. Finally, endogeneity concerns are inherent to the study of green bonds. As there are countless factors influencing firm performance, it is difficult to properly isolate the relationship between green bonds and firm performance.

Future research could further explore how the relationship between green bonds and firm performance develops over time. As green bonds increase in popularity, the magnitude of the effect on firm performance may change. Rising popularity could mean that novelty wears off, but it could also mean that green bonds grow into a mature and valuable fixed income product. Furthermore, as earlier research indicates green bonds increase media attention and help build a larger investor base, firms may use the instrument for the sole purpose of boosting stock performance. This may affect the magnitude of the relation. It would be interesting to analyse if the amount to which a firm commits to the environment translates to the magnitude of the effect on firm performance. There is also more research to be done regarding mergers of firms that issue green bonds. It could be the case that there is a link between the environmental commitment of the target and the effect on firm performance. This would increase understanding of merger success rates and the stakeholder vs. shareholder debate.

As consequences of global warming are increasingly visible worldwide, it is important to gain insight into the commitment of the corporate sector to combat climate change and its subsequent effect on performance. A better understanding of this relation may give green firms a competitive advantage and stimulate the corporate sector to credibly commit to a greener future.

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Appendix

Table A1: Green bonds by industry

Summary statistics			
Level 1	Level 2	Count	Amount issued (B$)
Communications	Wireless Telecommunications Services	5	3,5
	Other	7	5,0
	Travel & Lodging	52	11,0
	Other	20	3,4
Consumer Discretionary	Automobiles Manufacturing	24	11,0
Consumer Staples	Consumer Products	6	0,8
	Food & Beverage	11	3,6
	Other	5	1,0
Energy	Refining & Marketing	13	1,2
	Renewable Energy	284	23,9
	Other	3	0,6
Financials	Banks	642	179,3
	Commercial Finance	34	6,0
	Consumer Finance	97	20,7
	Diversified Banks	50	31,1
	Financial Services	50	5,4
	Life Insurance	14	6,5
	Real Estate	523	77,0
	Other	5	3,8
Government	Government Agencies	168	43,5
	Government Development Banks	125	78,9
	Government Local	86	10,0
	Government Regional	97	40,5
	Sovereigns	39	105,2
	Supranationals	550	109,4
Health Care	Other	6	1,9
Industrials	Electrical Equipment Manufacturing	7	1,4
	Industrial Other	75	11,7
	Machinery Manufacturing	5	1,4
	Transportation & Logistics	47	25,5
	Waste & Environment Services & Equipment	29	7,7
	Other	4	1,3
Materials	Chemicals	12	4,9
	Containers & Packaging	8	3,7
	Forest & Paper Products Manufacturing	28	7,2
	Metals & Mining	7	2,5
	Other	2	0,5
Technology	Hardware	9	1,9
	Semiconductors	11	5,4
	Other	6	4,8
Utilities	Power Generation	315	80,1
	Utilities	263	111,7
Total		**3744**	**1056,0**

This table presents the green bonds issued per type of industry and the cumulative amount issued that year in billion USD. The industries are sorted on two different levels, using the Bloomberg Industry Classification System.

Table A2: M&A deals by country

Summary statistics			
Country	Number of deals	Average transaction value ($mil)	% of total
China	**22.355**	**102,8**	**15,66%**
China	22.355	102,8	100,00%
Europe	**42.862**	**288,3**	**30,02%**
Austria	715	265,9	1,67%
Belgium	853	708,9	1,99%
Denmark	443	118,9	1,03%
Finland	530	146,6	1,24%
France	5.456	690,2	12,73%
Germany	3.728	697,1	8,70%
Guernsey	498	63,9	1,16%
Ireland-Rep	1.060	412,2	2,47%
Italy	2.517	237,9	5,87%
Luxembourg	490	1448,3	1,14%
Netherlands	1.153	596,8	2,69%
Norway	1.392	184,4	3,25%
Poland	2.217	41,7	5,17%
Russian Fed	1.820	224,8	4,25%
Spain	1.731	486,1	4,04%
Sweden	2.410	65,7	5,62%
Switzerland	1.517	751,3	3,54%
Turkey	473	26,9	1,10%
United Kingdom	11.688	170,1	27,27%
Other	2.171	115.9	5.07%
North-America	**75.518**	**474,9**	**52,89%**
Canada	19.673	96,2	26,05%
United States	55.845	648,3	73,95%
Country unknown	2.050	163,6	1,44%
Total	**142.785**	**347,1**	**100,00%**

This table presents the M&A deal sample sorted by continent and country of the acquirer. This data is extracted from the Thomson One database based on the following criteria: (1) Public status of the acquirer. (2) Deal announced between 01-01-2005 and 31-03-2021. (3) The acquirer is based in Europe, North America or China.

Table A3: M&A deals by industry

Summary statistics			
Industry	Number of deals	Average transaction value ($M)	% of total
China	**22.355**	**102,8**	**15,66%**
Consumer Products and Services	1.039	62,6	4,65%
Consumer Staples	1.603	88,7	7,17%
Energy and Power	1.902	114,5	8,51%
Financials	379	212,8	1,70%
Government and Agencies	6	251,7	0,03%
Healthcare	1.836	74,9	8,21%
High Technology	3.309	82,4	14,80%
Industrials	4.727	95,4	21,15%
Materials	4.165	116,1	18,63%
Media and Entertainment	819	92,3	3,66%
Real Estate	1.211	146,8	5,42%
Retail	726	184,4	3,25%
Telecommunications	633	117,7	2,83%
Europe	**42.862**	**288,3**	**30,02%**
Consumer Products and Services	3.446	96,4	8,04%
Consumer Staples	1.929	464,9	4,50%
Energy and Power	3.512	520,8	8,19%
Financials	7.213	311,5	16,83%
Government and Agencies	6	89,1	0,01%
Healthcare	2.273	503,9	5,30%
High Technology	5.829	95,6	13,60%
Industrials	5.678	252,1	13,25%
Materials	3.427	385,8	8,00%
Media and Entertainment	3.213	313,1	7,50%
Real Estate	3.312	172,4	7,73%
Retail	1.498	274,4	3,49%
Telecommunications	1.526	558,7	3,56%
North-America	**75.518**	**474,9**	**52,89%**
Consumer Products and Services	4.220	306,8	5,59%
Consumer Staples	2.313	835,1	3,06%
Energy and Power	6.852	556,7	9,07%
Financials	12.692	410,3	16,81%
Government and Agencies	18	97,8	0,02%
Healthcare	6.851	783,2	9,07%
High Technology	11.754	553,6	15,56%
Industrials	7.153	537,6	9,47%
Materials	11.348	161,3	15,03%
Media and Entertainment	2.784	883,4	3,69%
Real Estate	4.883	208,1	6,47%
Retail	2.905	815,7	3,85%
Telecommunications	1.745	944,3	2,31%
Industry unknown	2.050	163,6	1,44%
Total	**142.785**	**347,1**	**100,00%**

This table presents the M&A deal sample sorted by continent and country. This data is extracted from the Thomson One database based on the following criteria: (1) Public status of the acquirer. (2) Deal announced between 01-01-2005 and 31-03-2021. (3) The acquirer is based in Europe, North America or China.