# The Impact of Corporate Green Bonds on the Debt Financing of Firms

An Empirical Investigation

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Master Thesis

MSc in Advanced Economics and Finance

Copenhagen Business School

May $17^{th}$, 2021

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No. of pages (characters): 114 (258,482)

[1]The authors would like to express their sincere gratitude to Ramona Westermann for her invaluable guidance throughout the thesis writing process.

**Abstract**

This thesis examines the interaction between debt financing decisions by firms and access to green bond capital markets for the time period 2013 - 2019. This relationship is currently an unexplored topic in the academic literature, however, the rapid growth of the emerging green bond market makes it a topic of great interest to both academics and professionals. The insights into these debt financing decisions provided by this thesis, might offer valuable information for future work investigating sustainable capital markets as well as firm decisions in particular concerning sustainable investment by firms and their capital structure. Having identified this opportunity for research, we employ empirical tools from the well established corporate finance literature to offer initial findings on the topic of corporate green bonds and debt financing.

Firstly, firm debt financing decisions are studied in a broad sense by assessing whether green bond issuing firms maintain significantly different leverage ratios. Our work follows in the footsteps of Faulkender and Petersen (2006) as we view the issuance of a green bond as a proxy for expanded capital market access. The analysis for a sample of North American firms suggests that green bond issuing firms do in fact have higher leverage ratios, while an examination of an international sample yields no significant results. After the initial analysis the leverage ratio is broken down by maturity. We analyse how access to the green bond markets affects the long and short-term components of debt that firms choose to maintain. Here the results indicate that green bonds factor into the overall leverage ratio through long-term debt. The final part of the analysis focuses on the interaction between debt categories and thereby introduces green bonds to the literature on debt heterogeneity (Rauh and Sufi, 2010; Colla et al., 2013). We find that green bond issuers on average spread their debt financing across a more diverse set of instruments compared to conventional bond issuers.

We are, to our knowledge, the first who examine the specific interaction between corporate green bonds and debt financing decisions. Very recent work by Flammer (2021) has served as a foundation for several arguments presented throughout the thesis. The novelty of our findings highlights the importance of academic research being undertaken within this area of finance. It thus presents an opportunity for future work as the green bond market shows little sign of slowing down.

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# 1 Introduction

Given recent geopolitical developments, international efforts to curb global warming have been garnering increased attention and the importance of reducing carbon emissions seem more imminent than ever. While emissions have continued to rise on a global scale throughout the past decade, counteracting and more positive developments have also begun to emerge; perhaps most notably the scientific advancements within renewable energy (McCrone, 2019). A key element in the battle against climate change and the ambition to maintain current temperature levels will be the action taken by corporations. Private companies are an integral part of all aspects of life and sustainable solutions must, therefore, be developed as well as implemented by them. According to the World Economic Forum more than 370 companies with an aggregated market value of over 3.6 trillion dollars have committed to becoming carbon neutral by 2050 (Tricoire and Blum, 2021). There is little doubt that this transformation requires significant investment, meaning capital markets will see increased demand from firms to finance their sustainable projects. One important question, however, arises; *where is the money going to come from?*

In 2021 the corporate green bond appears to be one of the, perhaps many, answers to that question. Having set year-on-year records since its emergence in 2013, corporations have found value in a debt instrument for which funds are earmarked for 'green' projects. This is an encouraging development which also is laying the foundation for additional sustainable or social financial instruments (BloombergNEF, 2021). While the environmental urgency that green bonds represent is more than enough justification for a more rigorous investigation of their merit, other interesting questions not related to company emissions present themselves. As climate change is not a new phenomenon one fundamental question is; *why are green bonds necessary?*. Nothing prevents corporations from raising capital using conventional methods and directing the proceeds towards sustainable projects aimed at reducing carbon emissions. While corporations for years have been advocating for *corporate social responsibility* (CSR) and more recently *Environmental, Social and Corporate Governance* (ESG) the establishment of a distinct financial market signals further commitment from both companies and investors. The green mandate among corporate investors is increasing at a speed that has forced the

market for green bonds into a state of under-supply (MacAskill et al., 2020).
As pointed out by Flammer (2021) very little is known about this new financial instrument, thus the avenues for exploration are many. One particular direction does, however, seem neglected by current academic research. Debt financing is a key component of corporate activities and the need to understand the influence of new debt instruments is vital. Therefore, the investigation of corporate green bonds in the context of firms' debt structure is necessary to better understand debt financing decisions as capital markets become more sophisticated.

## 1.1 Problem statement

The academic literature related to the debt financing decisions is continuously developing. From static theories into more dynamic models and specialised research questions. As will be elaborated upon, classic topics within debt decisions e.g. taxes, bankruptcy, agency costs and information asymmetry are examined both theoretically and empirically. From this considerable body of work emerge many interesting predictions and findings. Given the complexity of a firm's debt financing decisions academic work tends to focus on specific aspects i.e. overall leverage (Frank and Goyal, 2009), dynamic adjustments (Leary and Roberts, 2005), market access (Faulkender and Petersen, 2006), debt heterogeneity (Rauh and Sufi, 2010) or the business cycle (Halling et al., 2016).

When examining corporate debt decisions in relation to green bonds there appears to be a significant knowledge gap in the literature. The very recent paper by Flammer (2021) is to our knowledge the only academic work that focuses solely on corporate green bonds. Her paper attempts to address the question of why firms might want to issue a green bond. This is an important empirical question with many possible answers. She highlights the information benefit of issuing a green bond as reflected in firm equity valuation, but the exact underlying dynamic remains a question for future research. Nevertheless, neither Flammer (2021) nor other early work on green bonds (Baker et al., 2018, Karpf and Mandel, 2018) address the question of what green bond issuance means for corporations at a more fundamental level. While we acknowledge that academic first-movers have been severely inhibited by the lack of data on corporate green bonds, this further highlights the potential as well as importance for emerging

work, such as ours, to relate the rise of corporate green bonds to the more fundamental debt financing decisions of the firm. Put more explicitly this paper addresses the following question:

**How does the access to green bond markets change the debt financing decisions of firms?**

To provide a more encompassing answer to the overall question we divide it further into three sub-questions. By answering these sub-questions individually we are able to provide broader insights into the debt financing decisions of firms. The following items, therefore, serve as a framework for our analysis.

1. Does the access to green bonds increase the reliance on debt financing for firms?
2. How does the issuance of a green bond affect the maturity structure of corporate debt?
3. How does green bond market access change firms' attitude towards other debt categories?

In order to conduct the outlined analysis we employ methodologies from other sources within the broader corporate finance literature. By combining existing and already well examined methodologies and implementing them to analyse the corporate green bond market we establish new and green bond focused findings. Addressing sub-question 1. we utilise the framework of Faulkender and Petersen (2006), wherein they use credit ratings as a proxy for access to the corporate bond market. The authors try to understand the interaction of this variable with a firm's leverage ratio to determine if firms rely more heavily on debt, when faced with more supply. In a similar vein we use the observation if a firm has issued a green bond as a proxy for market access to the newly emerging green capital markets.
In a next step we break the leverage down by maturity to assess where green bonds factor in. Again we base our methodology on the approach of Faulkender and Petersen (2006) and run the debt market access regression, however, using long-term leverage and short-term leverage as dependent variables. Our results show that green bond market access does not uniformly affect market leverage, but that there is a distinction in the long-term leverage and short-term leverage ratio maintained by firms with green bond market access.

For the final question stated above we investigate the nature of our sample firms' debt in greater detail. By focusing on the degree to which a firm's issued debt is concentrated in specific debt categories we try to assess whether green bond market access makes firms use a wider variety of debt instruments or if they choose to specialise on specific categories. For our methodology we once again turn to well established papers within the corporate finance literature and follow the example of Colla et al. (2013) and Halling et al. (2020).
Our findings focus on a new aspect of the green bond market, however, utilises methodologies already well established in the corporate finance literature and typically applied in a different context. This should lend credibility to our results. Our contribution offers insights into the statistical relationships that determine a firm's debt financing choices. These findings can act as guidelines for future research and as templates to build more theoretical frameworks on.

## 1.2 Scope of the Paper

The overall aim of this papers is to add to the financial literature relating green bonds and debt financing decisions. The conclusions reached in this paper are based on econometric analysis performed on quarterly financial information for two distinct samples from 2013 to 2019. Given the infancy of the green bond market we cast a wide net in terms of geographical scope to increase the number of useful observations, but with some exclusions; the most noteworthy of which being China. The exclusion of China from the analysis is due to the difficulty in obtaining reliable supporting data on firm characteristics. Our samples are based on the reporting in our main data source, Compustat, and are thus divided into a North American sample and an international sample. While the international sample mostly consists of European firms there are likely to be differences in debt financing decisions across countries (Rajan and Zingales, 1995). Country specific differences, primarily of regulatory nature, are, however, considered out of scope.

The paper's scope encompasses overall leverage, maturity as well as specialisation considerations and incorporates commonly used firm controls. Other valuable controls related to the macro environment of the firms as well as considerations related to corporate governance are not considered. Furthermore, other aspects of firm debt structure such as seniority of different

debt instruments as well as the use of covenants will not be included in the analysis. The reader must therefore be made aware that the conclusions presented in this paper do not consider the full complexity of firms' debt financing decisions, but should be viewed as early work in the hopefully growing corporate green bond literature.
Since our main question of interest relates to the implication of access to green bond markets our measure for market access must be addressed. By limiting our metric to the observation that a firm has issued a green bond, we automatically risk excluding firms who have the option to issue a green bond, but choose not to. Other potential measures of market access e.g. the ESG score of a firm can unfortunately not be included in the scope of this paper as data quality and consistency is too poor at this point in time.

The novelty of the results presented in this paper with respect to green bonds has the implication that primarily classic theories of firm capital and debt structure are related to the empirical findings. This choice is supported by the relative short period of investigation. As our green bond observations are clustered around the years 2018 and 2019, the potential for investigation of green bonds in relations to dynamic debt structure is at this point not present. While we acknowledge the importance of examining debt financing decisions in a dynamic setting, we limit our focus on this area of research to our review of the literature. Similarly, the rollover of corporate green bonds is outside the scope of this paper and firms, for which a green bond issuance is observed, are thus viewed as green bond issuers for the remaining sample period. Lastly, the theoretical work related to green bonds specifically is virtually non-existing, thus we make the decision to base our conclusions on existing theoretical work rather than bring forth any theoretical contributions of our own.

### 1.3 Structure of the Paper

The structure of this paper is as follows. Section 2 provides an overview of some facts and key developments in the green bond market. Subsequently, we summarise the theoretical underpinnings of our analysis by first reviewing the existing corporate finance literature relevant to our research questions in section 3.1 and then presenting the existing academic literature on green bonds in section 3.2. In section 4 we describe our approach to sample construction, our data sources, our data handling and provide detailed descriptions of the variables used for our analysis. We further elaborate on the analysis and specifically the methodologies and models we employ in section 5. Section 6 acts as a precursor to our main findings as we introduce the reader to some key descriptive statistics of our data sample. Furthermore, we make initial hypothesis about the correlations we might expect from our estimation results. We present our key results and discuss their importance for firms' debt financing decisions in section 7. A discussion of our analysis' limitations and its implications for further research is presented in section 8. Finally, section 9 concludes the paper.

# 2 Green Bonds - An Overview

With the increasing political emphasis on the global climate crisis and the associated policy changes, so too have financial markets responded to the shifting global paradigm. Increasingly governments and corporations require capital dedicated to environmentally friendly agendas, sparking the emergence of new financial instruments. In 2020 the debt raised for sustainable projects was approximately 750 billion USD (Bloomberg, 2021). Most notable among these debt instruments is the emergence of green bonds, which are debt instruments, whose proceeds are dedicated exclusively to financing environmentally friendly projects. As the most mature segment within the ESG debt markets more than approximately 305 billion USD were issued in 2020 alone (Bloomberg, 2021).

## 2.1 History and Emergence

Debt instruments allocated exclusively to sustainable or environmentally friendly projects are a relatively new concept, with the first such debt instrument being the "Climate Awareness Bond" from 2007 issued by the European Investment Bank (EIB). Soon after, in 2008 the World Bank issued the first bond labelled specifically as "green", which has acted as an example for subsequent issuances. The first corporate green bond was brought to market in 2013 through the collaboration of a Swedish real estate developer Vasakronan and the Swedish bank Skandinaviska Enskilda Banken (SEB). Since its inception this market has experienced substantial growth, however, its overall size relative to the conventional bond market still remains limited with 1% - 2.2% (Deschryver and De Mariz, 2020).

With the emergence of these new debt instruments, investor demand has increased in kind. Increasingly investors have been incorporating ESG mandates into their investment strategies. Next to dedicated green bond mutual funds, European pension funds in particular have been driving forces for the increased demand for green bonds. The scope of investors has gradually been increasing to include impact investors, insurance companies and asset managers. On the issuer side, green bonds have been used as a means to signal commitment to socially responsible investing (SRI). Corporations can use the green bond label as a tool to emphasise their social responsibility, which in turn has also yielded increased investor demand for their green debt instruments compared to conventional debt instruments (Deschryver and De Mariz,

2020). Generally, the market for sustainable debt instruments faces a problem of under-supply, which is preventing it from growing into a larger segment within capital markets. Currently, the green bond market share of the total fixed income market is too small to warrant broad demand from investors and remains a relatively undiscovered part of the overall securities environment.

## 2.2 Key Characteristics

### 2.2.1 Certification and Classification

One difficulty the green bond market faces is the lack of unified certification standards. As of writing, there are several institutions, which have created differing classification standards, causing uncertainty for investors seeking to fulfil an ESG mandate. Furthermore, this lack of standardisation impedes the growth of the green bond market as it undermines the integrity of the green debt instrument issued (Tang and Zhang, 2020). As a positive externality, the fragmentation of the green bond classification standards has sparked the emergence of similar debt instruments such as climate, social or sustainable bonds and loans (Deschryver and De Mariz, 2020). Deschryver and De Mariz (2020) identify several entities, which have created green bond classification standards. The common denominator within these guidelines is the detailed explanation for use of proceeds of the raised funds.

Firstly, the Green Bond Principles are a set of guidelines for the issuance of green bonds, which focus on four main principles spanning use of proceeds, selection of projects, funding and reporting (ICMA, 2017). The principles, especially with respect to reporting, emphasise the importance of transparency. While it is acknowledged that green projects can also have a social component, any project undertaken which intentionally has a mix of green and social benefits cannot be labeled as a green bond, but will instead be considered a sustainability bond.

Secondly, the Climate Bond Initiative (CBI), an international charity, has created a set of standards, which is intended for investors and governments to use as a means to identify and prioritise environmentally friendly investments. They are closely linked to the Green Bond Principles with respect to reporting and management of proceeds (CBI, 2020a). To obtain

the CBI certification the green bonds must be verified by an approved third party, which is required to conduct post-issuance verification approximately 24 months after issuance. Lastly, a small fee is paid for the certification in the amount equal to 1/10 of a basis point of the notional on the bond.

Thirdly, the EU's Technical Expert Group (TEG) has developed a definition of green bonds and finally national and regional governmental bodies have developed frameworks for the identification and labelling of green bonds. Overall, none of these standards are strictly binding or universally used as a means of identification. As a result, critics have called the integrity and potential of the green bond market into question as this fragmentation of classification standards opens up an opportunity for *green washing* or falsely signalling a green agenda. Existing literature, however, does not find evidence to support this hypothesis (Flammer, 2021).

### 2.2.2 Who Issues a Green Bond?

Since the CBI began their collection of data on green bonds the market has set year-on-year records in terms of total issuance. While development banks were the first adopters of this new financial instrument the impressive growth in the issuance of green bonds can be attributed to the growing interest from corporations. While corporate issuances accounted for less than 20% of the overall green bond market in 2013 this has grown to above 50% in 2019 (Almeida, 2020). The total issuance in 2019 was 259 billion USD which was an increase of 51% compared to 2018 and the total number of issuers increased by 46%. Currently the largest issuer in the world measured by both amount and number of bonds is the US Federal National Mortgage Association. The United States also leads the pack in terms of issuance (amount and number of bonds) with other countries such as China, France and Germany following suit.

One important aspect for the sustained viability of the green bond market is the continued support from issuers. In 2019, 66% of the total volume was contributed to existing issuers with the trend being present across different types of issuers. 2019 also saw issuance from all parts of the world with Europe being the biggest regional issuer followed by Asia-Pacific and North America. It was also the year in which EUR overtook USD at the primary currency of issuance (40%). The overall size of a green bond also increased to an average 144 USDm (up

from 108 USDm in 2018)[2] and in general more bonds above 100 USDm were issued in 2019. The proceeds are used for a variety of green projects with energy (32%) being the biggest category ahead of building (30%) and transportation (20%) (Almeida, 2020).

The segment for corporate green bonds has increased significantly with non-financial corporations doubling the issuance amount compared to 2018 and ending at a total of 59.1 billion USD for the year. Despite sovereign green bonds seeing significant growth, corporate green bonds continue to dominate the overall green bond landscape. Financial corporations, however, stagnated in 2019 as they saw a massive increase between 2017 and 2018. The corporate segment also saw a decrease in issuance for the first half of 2020 with non-financial corporations remaining on par with 2019. As the global bond market grew throughout the pandemic the green bond market experienced a minor set-back indicating that issuers, to a certain degree, reverted back to more familiar terrain (CBI, 2020b). Certified green bonds appeared the most robust segment of the green bond market. While 86% of green bonds in 2019 had external review in some form or another only 12% actually received CBI certification. This was, however, almost double of the certified volume in 2018 (Almeida, 2020).

[2]Figure includes the US Federal National Mortgage Association

# 3 Literature Review

This section introduces the academic literature related to our topic of interest. As our thesis is placed within one of the largest areas of the finance literature the review will focus on the most relevant parts within the vast body of academic corporate finance literature. We outline the foundation as well as important streams of the literature in which academics attempt to answer more focused questions regarding firm financing. Given the more narrow focus of our thesis some papers will have greater relevance than others, but it is important to understand the related questions being asked and answered in the literature. Section 3.1 elaborates on more classical capital and debt structure theory as well as empirical studies, while section 3.2 focuses on the emerging green bond literature.

## 3.1 Capital and Debt Structure

The optimal capital structure of firms has for decades been of great interest to academics and corporations alike. Since the seminal work of Nobel laureates Modigliani and Miller (1958) various theories and empirical models have attempted to answer these capital structure questions. The focus of this paper is on the debt financing decisions of firms, nevertheless, one cannot discuss debt financing without taking the broader considerations of capital structure into account. The following sections will thus outline the main theories and empirical work related to firms capital structure and from there transition into more debt specific topics.

### 3.1.1 Static Capital Structure

In their paper from 1958, Modigliani and Miller (MM) present a proposition of debt irrelevance (Proposition I) stating that *"the market value of any firms is independent of its capital structure"*. They prove this by showing that any investor can create their own asset portfolio by borrowing by themselves and thus any levered company cannot be valued at a premium compared to a fully equity financed firm. The result rests on the assumption of *perfect markets* meaning capital markets without frictions i.e. firms can issue both debt and equity whenever they wish and investors are able to borrow at the risk-free rate. Equally important is the notion of no taxes and no cost of bankruptcy (Modigliani and Miller, 1958). They expand the argument through *Proposition II*, which states that the cost of equity is related to the debt-

to-equity ratio, the cost of debt as well as the return on assets. While higher leverage will increase the expected returns to equity, looking across all securities the average cost of capital is unchanged and as a result firm value remains unaffected by the debt financing decisions of firms (Modigliani and Miller, 1958).

The notion of no taxes is subsequently relaxed in their paper from 1963 ultimately invalidating the original Proposition I as introducing taxes creates a key benefit of debt and increases the value of the levered firm. The result is straightforward, since debt is a tax-deductible form of financing, by introducing leverage additional income is created for the firm. Since no "cost" of debt is introduced firm value becomes an increasing function of leverage, however, MM note that it is not meaningful to think of the fully debt financed firm as being the optimal capital structure (Modigliani and Miller, 1963). MM do not challenge the existence of *cost of debt* (Miller, 1977), but do consider them disproportionally small compared to the advantages of debt. Despite this Miller (1977) notes the puzzling empirical evidence showing that corporate leverage ratios have only gone up marginally since the 1920's despite much higher tax rates. By introducing personal taxes he shows that individual firms do not have an optimal debt-ratio, but rather an optimum aggregate debt level. Firms with lower leverage will attract investors with relatively high personal tax rates and vice versa i.e. a so-called *clientele effect* is at play. Miller argues that in a world in which income from stocks and equity is not taxed at the same rate market mechanisms will drive both yields and ownership structure to a point at which corporations cannot gain from issuing more debt. Thus, the value of any firm once again becomes independent of its capital structure (Miller, 1977).

The paper by Miller (1977) is one example where the benefits of debt are equated with the costs of debt. While Miller maintains the irrelevance proposition of MM (1958), other papers propose that a static trade-off decision can affect firm capital structure as well as firm value. When talking about benefits of debt it is most common to refer to the tax shield created from the interest deductions associated with corporate debt as presented by MM (1963). On the the cost side a distinction is typically made between the agency costs of debt (Jensen and Meckling, 1976; Myers, 1977) and cost of bankruptcy (Kraus and Litzenberger, 1973). Since debt is a legally binding obligation to pay a certain amount, one major drawback of previous

work such as MM is the assumption that the firm will always be able to pay back the relevant amount. Kraus and Litzenberger (1973) argue that introducing both corporate taxes as well as cost of bankruptcy, i.e. penalties to the firm for states in which it is not able to repay its debt obligations in full, change how firms optimally use debt in their capital structure. Most importantly they show that, unlike MM (1963), firm value will not be linear in leverage and in fact market value of the firm is not necessarily a concave function.

Naturally, determining the exact cost of bankruptcy (or financial distress) is an empirical question. Andrade and Kaplan (1998) find financial distress costs to be 10-20 % of firm value. They come to this conclusion by examining high-leverage-transaction (HLTs) in the 1980's that ultimately ended up in financial distress. By focusing on relatively healthy firms they argue that they can isolate the costs which are a direct result of high leverage and not the general fortune of the firms. The approach suffers an endogeneity problem in that only distressed firms are investigated. If firms have high costs of default one would expect them to use much lower leverage *ex ante*, thus the study by Andrade and Kaplan might be biased towards firms with lower cost of bankruptcy.
Glover (2016) addresses this issue by setting up a dynamic model accounting for tax shields, distress costs, macroeconomic risk and costly adjustment of capital structure. Simulating his approach across the entire economy he finds the average cost of default to be 44.5% with realised costs of default much lower at around 25%. This would indicate that firms with lower costs of default do in fact use leverage to a greater extend.

In addition to pure cost of default, debt also adds complexity to the capital structure of firms and thereby changing the incentive of stakeholders which is more commonly referred to as *agency costs of debt*. The two most prominent kinds being *asset substitution* (Jensen and Meckling, 1976) and *debt overhang* (Myers, 1977).

Jensen and Meckling (1976) define the agency relationship as a contract under which some decision making authority is transferred from one person (principal) to another (agent/manager). Agency costs occur as it is impossible for the principal to secure optimal behavior of the agent without incurring cost. Generally, debt can also serve to mitigate harmful spending from the

manager as payments to debtholders reduce the free cash flow at the manager's disposal. On the other hand Jensen and Meckling (1976) show that a manager, who is fully aligned with equity, will have the incentive to change the underlying risk of the firms assets by undertaking a more risky investment even though the impact on firm value is negative. The loss in firm value from this sub-optimal investment policy is the agency costs of debt. It is important to emphasise that this cost ultimately is being incurred by equity owners since debtholders will anticipate this incentive *ex ante* and, therefore, not be willing to pay as much for the corporate debt claims. For this reason, it is in the interest of equity owners to minimise agency costs *ex ante*. Since equity is equivalent to a call option on the firm value (Merton, 1974) it has limited downside and it is in the interest of equity owners to increase the risk to capture more upside *ex post*. Debtholders, on the other hand, have no upside and are therefore interested in the firm investing in safer assets.

Myers (1977) presents another perspective on agency costs of debt which also stems from the investment policy of the firm. He shows that a firm having issued risky debt might not undertake certain investment opportunities even though they have a positive net present value (NPV). If the investment is financed by equity, the additional issuance effectively transfers wealth to existing debtholders. Investments increasing firm value are, therefore, not attractive from an equity owner's perspective. Myers assumes that firm value consists of assets in place and the value of future growth opportunities. Since future opportunities are at the firms discretion to undertake they are regarded as *real options* i.e. their value depends on the firms ability and willingness to exercise them. The key result has one important implication for empirical work related to capital structure since a firm with more valuable growth opportunities (real options) should issue less debt to reduce the agency cost of debt associated with *debt overhang*. Additionally, one should expect more profitable firms to rely more on debt financing as they are less likely to suffer from this type of investment distortion. Like Jensen and Meckling (1976), Myers (1977) develops his model assuming no cost of bankruptcy. In a real world scenario corporations obviously suffer from cost of debt both related to agency conflicts and the probability of default.

In a later paper Myers (1984) discusses the possibility of firms not having an optimal debt level, but simply issuing securities based on their information sensitivity. Since capital structure choices can convey information to investors, firms prefer internal financing to debt which in turn is preferred to equity as it is the most information sensitive. This is also called *the pecking order theory*. The theory is based on the empirical observation that stock prices react to firms issuing securities. Generally, investors react negatively to the issuance of equity as it implies that the firm believes its shares are overvalued. Debt sends a more neutral signal whereas internal financing signals that the firm is in good shape. As a result, the optimal debt-equity ratio of the firm is not defined in a static sense, but as a result of the fortune of the firm as well as the investment opportunities available (Myers, 1984). It expands on the work of MM in the sense that the actual debt-equity ratio is irrelevant for firm value if information effects are disregarded. Since financing decisions convey information to the outside world, the capital structure of firms does have an impact on firm value. Especially when the manager has more information, he might find it optimal to pass on positive NPV projects if the informational asymmetries are too great (Myers and Majluf, 1984).

The key assumption of asymmetric information relates to the work of Akerlof (1970) and Spence (1973) who show how informational asymmetries and the cost of overcoming them have significant impact on markets. In the context of corporate capital structure Ross (1977) theorises how a firm can signal its true type to market participants through the issuance of risky debt and in turn this can create a separating equilibrium. This is important as the MM proposition assumes that market participants have full information about a company's future stream of income. In reality it will be valued based on the *perceived* stream of income. So as Ross (1977) argues, a firm is able to change its perceived risk class through the issuance of debt, despite its actual risk class being unchanged.

### 3.1.2 Empirical Evidence

Much of the presented theoretical literature has been tested empirically with results both in favor of the *trade-off* and *pecking order theory*. Shyam-Sunder and Myers (1999) test the predictions of the pecking order theory and find better explanatory power compared to the static trade-off theory. They test a target adjustment model against the pecking order for

which they define the variable *funds flow deficit* (DEF)[3]. They test the pecking order by regressing the variable on the change in the absolute debt level of long-term debt. If the theory holds one would expect a coefficient of 1 i.e. all external financing needs are covered by issuing debt. The target adjustment model, on the other hand, predicts firms to adjust their capital structure only when deviating from its optimum (Shyam-Sunder and Myers, 1999).
While Shyam-Sunder and Myers (1999) find greater support for the pecking order, Chirinko and Singha (2000) argue that their test in fact do not account for the order of security issuance in that firms could easily use little equity first and only then using debt resulting in similar statistical results.
Shyam-Sunder and Myers (1999) argue that the simple pecking order works well for their sample of mature firms. This is in slight contrast to expectation as mature firms typically have lower information asymmetries. Nevertheless, Frank and Goyal (2003) also find that the pecking order works best for larger firms. Additionally, when examining the financing deficit they find that equity issuance tracks the deficit much better than debt. They also show how the financing deficit does not remove the explanatory power of conventional firm characteristics as predicted by the pure pecking order.

Conventional leverage regressions use specific firm metrics as proxies for firm characteristics, with the main problem being that often more than one possible proxy exists. Empirical literature has, however, found certain proxies to be consistently good indicators of firms' capital structure decisions. Titman and Wessels (1988) find that debt ratios are negatively related to the uniqueness of a firm's products (measured by R&D expenditure) as well as profitability and that smaller firms tend to rely more heavily on short-term debt. These are both findings which are consistent with the trade-off theory as one should expect both specialised and smaller firms to have higher agency costs of debt. Interestingly, they do not find evidence of a relationship between the growth opportunities of firms and their debt ratio.

[3]The Funds flow deficit is defined as $DEF_t = Div_t + X_t + \triangle W_t + R_t - C_t$

With variables being 1) Div = Dividend payments, 2) X = Capital expenditures, 3) W = Working capital, 4) Current portion of long-term debt, 5) C = Operating cash flow (after interest and tax)

In a study across 7 developed countries Rajan and Zingales (1995) find, with few deviations, a statistically significant relationships between debt and the tangibility of assets (+), growth opportunities (−), size (+) and profitability (−). The negative coefficient of growth opportunities (proxied by the market-to-book ratio) is consistent with the debt overhang argument (Myers, 1977) and the coefficients for size and tangibility are also thought to be in line with theoretical work since larger firms with more tangible assets are thought to suffer less from agency cost of debt and have lower costs of bankruptcy. The negative coefficient for profitability has been used as a key argument against the trade-off theory (Shyam-Sunder and Myers, 1999) since more profitable firms should be able to take on additional debt, *ceteris paribus*, due to the increased tax shield. Strebulaev (2007) shows that in a model which incorporates refinancing points the coefficient for profitability is actually in line with expectation. Since cross-sectional tests can not distinguish whether a firm has a different optimal ratio or their actual ratio is simply different from their optimal (Myers, 1984 ) regression results will depend greatly on whether firms are at a refinancing point or not. The paper shows that if firms only adjust their capital structure at certain points of firm value the negative relationship between profitability and leverage is not surprising since leverage becomes a small part of the overall firm value (for more profitable firms). Strebulaev (2007) then goes on to show that at refinancing points the relationship turns positive just as predicted by theory.
Frank and Goyal (2009) confirm the importance of tangibility, profits, size and growth opportunities. In a study of American firms from 1950-2003, they find relationships in line with earlier work concluding that the above mentioned firm characteristics are reliably important for firm's capital structure. Furthermore, they add that the median leverage of the industry and inflation also consistently predict firm capital structure, with both variables entering with a positive coefficient.

Academic literature has not yet reached a verdict in the debate between *the trade-off theory* and *the pecking order theory*. Empirical evidence seem to suggest that both theories have their merit (Leary and Roberts, 2010; Bradley et al., 1984; Frank and Goyal, 2003) with neither being able to fully explain the capital structure decisions of firms. An alternative explanation is offered by Baker and Wurgler (2002) who argue that a firm's capital structure is simply the cumulative efforts of managers trying to time the market i.e. by issuing equity

when it's relatively more valuable to do so. In their empirical investigation they find that market fluctuations tend to have a persistent effect on capital structure which is at odds with traditional views. Similarly, Welch (2004) claims that stock returns can explain about 40% of firm debt ratios and that previously used proxies have only been helpful in providing an explanation through their correlation with stock returns.

### 3.1.3 Capital Structure Complexity

*Dynamic capital structure*

One of the most challenged assumptions of traditional capital structure theories is the notion that firms can issue both debt and equity whenever they wish to do so. In other words, firms always have the opportunity to be at their "optimal" capital structure. In reality both equity and debt issuance are costly transactions for firms and the optimal frequency of capital structure adjustments thus very much depend on the magnitude of refinancing costs.

Some of the early work on dynamic capital structure decision comes from Fischer et al. (1989). Their theoretical model builds on the classic trade-off between tax benefits of debt and bankruptcy costs, but with the introduction of recapitalisation cost they move from the view of the firm having *one* optimal capital structure and turn their attention to an optimal debt ratio range. They are able to link firm specific characteristics to this new measure and find that smaller, riskier firms with a lower tax rate tend to have much wider debt ratio ranges. In past empirical work, there have been studies showing that a deviation from a firms leverage target or "optimal" capital structure has a long-lasting impact (Fama and French, 2002; Baker and Wurgler, 2002; Welch, 2004), however, the exact underlying dynamics are still disputed. Leary and Roberts (2005) also highlight the importance of adjustment costs. They find that the more costly it is for firms to refinance the less frequently they do so. They test this in relation to the market timing effect discussed by Baker and Wurgler (2002) and find that as adjustment costs increase the market timing effect becomes less significant. This also suggests an active rebalancing decision for firms.

Hennessy and Whited (2005) show that adjustment costs are not necessary to reconcile empirical findings with the trade-off theory. If firms endogenously decide on leverage, payouts and

investment then there will not be, in their model, a target leverage ratio, since firms are always at a restructuring point. Their model implies that leverage becomes path dependent since it is the result of the joint decision making of firms which in turn is affected by its realised cash flows (Hennessy and Whited, 2005).

The dynamic adjustment of capital structure can also be driven by financial flexibility as discussed by Byoun (2011). The need for financial flexibility depends on which maturity stage the firm is at. In his paper, Byoun suggest that developing firms will have low leverage in order to build up flexibility, while growth firms will have high leverage as they need to fund their growth opportunities. Mature firms have less growth opportunities and will thus have moderate leverage, giving firm leverage an inverse U-shape. While his findings do not entirely corroborate the traditional pecking order theory it does lend evidence to why the theory empirically holds better for mature firms who are thought to have less information asymmetries (Shyam-Sunder and Myers, 1999; Frank and Goyal, 2003). Smaller growing firms will quite simply rely more on equity as their need for financial flexibility is greater.
Financial flexibility can also help explain why some firms might prefer bank debt to public debt (Bolton and Freixas, 2000). Since banks are better equipped to help firms in distress through renegotiation, firms will value the added flexibility. However, the flexibility of bank debt comes at a higher price and, therefore, only firms with high demand for financial flexibility turn to bank debt.

The notion of financial flexibility is similar to the findings made by DeAngelo et al. (2011). They consider the cost of borrowing to include what a firm must forego in the future if it, due to leverage decisions, is unable to borrow further in the future. They introduce a model which includes *transitory debt* as it allows firms to more dynamically deviate from any leverage target to take advantage of current investment opportunities. Thus, a firm's *permanent leverage* is an indication of the, *ex ante*, value of being able to borrow in the future and thereby move away from its original target. Their findings both help explain why firms tend to adjust slowly and infrequently (Leary and Roberts, 2005) and why firms use debt more conservatively than predicted by traditional trade-off models (Graham, 2000). The results of dynamic adjustment suggest issuing debt when facing a financing deficit and retiring debt when faced with a surplus

in order to maintain borrowing capacity(DeAngelo et al., 2011). Similar results are found by Byoun (2008).

*Capital Structure and the Business Cycle*

Another branch of the academic literature adding to the complexity of traditional models is focused on macroeconomic conditions and their effect on capital structure. Much like equity issuance will tend to follow a level of cyclicality (Baker and Wurgler, 2002) the issuance of debt is also subject to the state of the wider economy. Korajczyk and Levy (2003) document that the issuance of debt is in fact counter-cyclical for firms who are financially unconstrained, but pro-cyclical for constrained firms. Constrained firms prefer to issue debt when the collateral value of their assets are high (Korajczyk and Levy, 2003) whereas the counter-cyclicality of unconstrained firms is based on an argument presented by Levy and Hennessy[4] (2007) in which an equity aligned manager prefers debt financing in recession i.e. when their own compensation is relatively low. The notion of debt being counter-cyclical is inconsistent with the trade-off theory in one important aspect as one should expect firms to take on more debt when times are good (pro-cyclical) as they are more likely to have tax benefits of debt. In their model macroeconomic variables are meant to proxy firm investment opportunities and they confirm that economy wide factors influence firm financing decisions and in fact they account for between 12% and 51% of time-series variation in firm leverage.

The counter-cyclicality of leverage is confirmed in a later paper by Hackbarth et al. (2006). Their theoretical model builds on the foundation of more traditional capital structure models (see Leland, 1994; 1998) but where the liquidation value in case of default depends on a given regime (H or L). The model predicts earlier optimal default in the L state of the economy and thus lower coupon payments and a lower book value of debt in recessions. On the other hand, the present value of future cash flows is lower in a recession and thus the denominator or the firm's leverage ratio is lower. In their model the second effect is the dominant one leading to counter-cyclical leverage (Hackbarth et al., 2006). A more dynamic model incorporating investor utility is presented by Chen (2010).

[4]In the paper by Korajczyk and Levy (2003) this argument is originally cited to a working paper by Amnon Levy (2001). The final paper was published in 2007 in collaboration with Christopher Hennessy.

The approach to model macroeconomic factors through regime changes (or dummies in empirical research) is fairly common in the literature, but as argued by Halling et al. (2016) this can only account for the *direct effect*. They argue that the business cycle also impacts leverage determinants e.g. growth opportunities might be sensitive to the state of the economy. Allowing for changes in leverage determinants and the coefficient estimates they find that leverage in general is counter-cyclical. This effect stands in contrast to Korajczyk and Levy (2003) as it is present for both constrained and unconstrained firms. A smaller portion of their sample does exhibit pro-cyclical leverage dynamics. This sample consists of firms which have more growth opportunities and less tangible assets i.e. higher loss given default (Chen, 2010).

Despite the large body of literature related to both adjustment costs and macroeconomic conditions and their effect on corporate capital structure, Lemmon et al. (2008) find that a large part of the variation in leverage ratios is the results of a time-invariant effect resulting in very stable capital structures over time.

The results suggest that there still remains unanswered questions concerning corporate capital structure. Rauh and Sufi 2012 find significant explanatory power in asset similarity i.e. the assets used in production by firms affect financing decisions. Zwiebel (1996) investigate the manager's role in choosing debt levels and show that a manager will voluntarily take on debt as a self-disciplinary measure. Morellec et al. (2012) find that relatively small values of agency costs of debt (1.5% of equity value) can explain why firms use debt much more conservatively than predicted by the traditional capital structure models (Graham, 2000). Finally, Billett et al. (2007) find that debt contract covenants can help reduce agency costs of debt as the negative relationship between firm leverage and growth opportunities found empirically is less pronounced when accounting for covenant protection.

*Capital Market Access*

While dynamic models as the ones discussed above break down the assumption of firms always adjusting to their optimal capital structure, they still implicitly assume that the firm *can* adjust if they so wanted, albeit at a cost. Especially on the debt side they do not consider that supply frictions might restrict certain firms from taking on the leverage they optimally would. As not all firms have access to public debt markets (bonds) Leary (2009) investigates

two instances of shocks to the availability of bank loans. He finds that bank-dependent firms which are typically smaller and less mature are more sensitive to changes in bank debt availability as they increase their leverage proportionally more during supply expansion (and vice versa). These firms also increase their reliance on long-term debt and use less equity when private debt markets are favourable. In times of contraction, larger firms with access simply shift towards public debt markets. Similarly, Chang et al. (2006) find that firms with higher informational asymmetries (proxied by analyst coverage) will typically be further away from their leverage target due to lending frictions and, therefore, be more active in adjusting their debt financing when markets become more favourable. These different reactions to supply side dynamics might also help explain the documented heterogeneity in firms' capital structure (see Welch, 2004; Lemmon et al., 2008).

Another paper which questions the previous demand-driven approach to firm capital structure is by Faulkender and Petersen (2006). They recognise that varying leverage ratios to some extend can be explained by firm characteristic, but maintain the importance of considering restrictions on borrowing. Using the observation that a firm has obtained a credit rating or not, as a proxy for access to public debt markets, they find that firms with additional borrowing possibilities do in fact have higher leverage. This is a particularly interesting result for other work examining the expansion of capital markets e.g. through corporate green bonds. Focusing on public companies from 1986-2000 they first document how a relatively small part of the sample (19%) have access to public debt markets, but these firms account for the vast majority of issued debt (78%). These firms are typically larger and more mature. Supply frictions also affect the maturity structure of corporate debt as firms relying on public debt use relatively more long-term debt. This is consistent with the notion that more mature firms tend to use long-term debt and growth firms rely on short-term debt as it is less constraining (Faulkender and Petersen, 2006). In general, their findings support the notion that firms forced to rely on e.g. bank debt will have to absorb the additional cost of information collection and imperfect monitoring and in turn will also have lower leverage.

In another empirical investigation between third party certification and leverage Sufi (2009) confirms the findings of Faulkender and Petersen (2006) by demonstrating that loan ratings

increase the supply of debt financing and thus firms' reliance on it. The specific channel seems to be an expansion of potential creditors who previously were at an informational disadvantage e.g. foreign banks. He extends the study by showing how this increase in supply leads to higher investment activities of the previously constrained firms (Sufi, 2009). The results follow from the theoretical notion that certification will help alleviate information asymmetries and thus the cost of evaluating default risk will be lower for new creditors *ex post* (Fama, 1990).

### 3.1.4 Debt Choices of Firms

*Bank vs. public debt*

Even though Faulkender and Petersen (2006) document that a firm's choice of debt is not entirely their own decision, academic literature has long been interested in the trade off between private and public debt. One key component of this decision is the monitoring provided by banks wherein public debt is thought to have less since it is more dispersed among investors (Diamond, 1984). Diamond (1991) proposes a model in which firms of mediocre credit ratings borrow from banks as they benefit from monitoring the most. On both sides of these firms monitoring either has no value (highly rated firms) or is simply not worth the additional cost (low rated firms). The underlying reason for this comes from a moral hazard problem. Borrowers will use bank monitoring as a way to build up a reputation and eventually make the switch to public debt.

Reputation effects are examined from the view point of lenders by Chemmanur and Fulghieri (1994) as they develop a model in which banks are interested in building a good reputation. Since it is ultimately the decision of lenders to either liquidate or renegotiate with a firm in distress they show how banks are using more resources in evaluating this decision in order to make the "right" one. For firms with a relatively higher probability of financial distress this reputation of banks has value as it minimises the risk of inefficient liquidation. In their model *the entrepreneur* has private information about the probability of default and lenders are chosen based on a trade-off between higher interest rates and greater flexibility (Chemmanur and Fulghieri, 1994). In equilibrium the use of bank debt dominates public debt, but very low risk firms prefer public debt as they avoid being pooled together with firms of higher risk meaning they can borrow at a lower market rate. An important implication of their model is

that renewal of a bank loans has a positive signalling value to the market compared to other debt. A result which is in line with Diamond (1991).

The theoretical models predict that firms with good credit rating and low probability of default are best able to borrow from public debt markets directly. In an empirical study Cantillo and Wright (2000) do indeed find that larger firms with significant cash holdings tend to borrow directly from public markets. Their findings support the theory presented on the advantage of bank debt in case of default, which comes at a cost (Diamond, 1991; Chemmanur and Fulghieri, 1994). Interestingly, they find that firms do not enter and exit public debt markets symmetrically i.e. once firms have relied on public debt they are less likely to revert back to bank debt despite firm characteristics suggesting it. Additionally, they show how macroeconomic variables such as lower risk-free interest rates will push firms towards the public debt market (Cantillo and Wright, 2000).

In line with Diamond's (1991) theoretical predictions, Denis and Mihov (2003) find, in an empirical study, that a firm's credit rating is especially important in determining the source of debt. Confirming the results of Cantillo and Wright (2000) they find that larger and more profitable firms use public debt. Denis and Mihov (2003) make the distinction between bank and non-bank private debt and show how firms with the lowest credit rating and poor performance rely mostly on non-bank private debt. Again in line with the predictions of Diamond (1991). The distinction is important as it highlights the importance of other financial intermediaries. Surprisingly, they don't find any significant relationship between a firm's growth opportunities and it's source of debt. This finding is at odds with the theory relating agency cost of under-investment to firm debt decisions (Myers, 1977). One explanation is that firms account for these costs through their choice of debt maturity rather than through the source (Johnson, 2003).

*Debt Characteristics*

Two distinct, but important, questions that firms need to make concerning their debt financing, concerns the seniority structure as well as maturity profile of debt. Myers (1977) argues that the shareholder-bondholder conflict arising in firms with more growth opportunities (options) could be alleviated by the firm issuing more short-term debt. Consistent with this notion Barclay et al. (1995) find that smaller firms with more growth opportunities rely more on short-term bank debt and larger firms with a credit rating have more long-term debt. Their findings are also consistent with Diamond (1993) in that firms with higher information asymmetries will have more short-term debt. They further investigate another result from Diamond in which firms use the maturity of their debt contracts to signal to the market, but does not find much support for this hypothesis. In general their empirical findings seem most in line with the *contracting-cost hypothesis* in which firms balance the additional cost of short-term debt related to more frequent issues and increased liquidity concerns with the benefit of financial flexibility (Barclay and Smith Jr, 1995).

More recently Choi et al. (2018) considers the dispersion of debt maturity and find it to be an important component of debt financing decisions. Having greater dispersion in the maturity structure will increase costs due to more debt issuance whereas a concentrated maturity structure will increase the rollover risk, especially when debt markets are contracting. As with other debt decisions (Faulkender and Petersen, 2006) market conditions do impact the optimal structure with their model predicting more dispersed maturities for firms with higher probability of financing constraints. Similar results are expected for firms with more growth opportunities as the risk of not being able to refinance is greater and their empirical findings show how existing maturity structures influence future debt financing decisions with firms selecting maturities for newly issued debt less used in the current structure (Choi et al., 2018).

Hackbarth et al. (2007) examine debt structure in relation to the trade-off theory. In their model they assume that banks are able to perform costless renegotiations which will lower cost of bankruptcy. Thus a pecking order effect exists within debt structure where firms prefer bank debt to public debt. Their model distinguishes between *weak* and *strong* firms where weak firms have no bargaining power in case of default. Weak firms thus rely exclusively on bank

debt as introducing market debt is detrimental to firm value due to premature bankruptcy. The strong firm on the other hand optimally relies on a mixed debt structure since it can create tax shields beyond what is feasible with only bank debt. In line with other work (Diamond, 1993; Park, 2000) bank debt is placed senior so as to increase the reservation value the bank faces in case of renegotiation. This is attractive since the bank debt does not create bankruptcy costs to the same extend as market debt (Hackbarth et al., 2007)

*Debt Heterogeneity*

A key aspect of firms' debt financing decisions is the complexity of their debt structure. While traditional work, both theoretical and empirical, assume debt to be one homogeneous block (Modigliani and Miller, 1958; Rajan and Zingales, 1995) the view on debt has slowly transitioned to add more and more complexity. One of the seminal papers recognising the heterogeneity of corporate debt structure is by Rauh and Sufi (2010). Their study explores the underlying dynamics of debt which is not observed in more high level studies. Using a sample of only firms with a credit rating[5] they find that the heterogeneity of debt depends on the credit quality of borrowers. Using six classifications of debt [6] they find that for the majority of firm-year observations (70%) firms rely on at least two different types of debt. More interesting is the finding that for 25% the underlying composition changes significantly without any notable change to the overall leverage. As previous work has shown (Denis and Mihov, 2003), their results suggest that credit quality of firms is a key determinant for debt structure heterogeneity. More specifically they find that high-quality firms tend to have less complex capital structures as they rely primarily on equity and senior unsecured debt. Lower quality firms on the other hand have several tiers to their debt structure (Rauh and Sufi, 2010).

While they confirm previous empirical findings relating firms characteristics to debt for overall leverage (Titman and Wessels, 1988; Frank and Goyal, 2009) they find that that these relationships are not uniform across debt instruments. Important for the pecking order theory they find that bank debt is actually weakly positively correlated with profitability[7]. Finally, they

[5]Following the work of Diamond (1991)

[6]The six classifications are 1) bank debt, 2) straight bond debt, 3) convertible bond debt, 4) program debt, 5) mortgage debt and 6) all other debt

[7]The negative relationship between leverage and profitability has been used as a strong argument against

examine a sub-sample of *fallen angels* i.e. firms that have gone from investment to speculative grade. Here a drastic change to the debt structure occurs in the year following the change in rating as firms increase their usage of subordinate debt and secured debt. Additionally, they find that the changes are made around debt with shorter maturity as more long-term debt is more likely to reflect their old rating. The results are distinct from previous work (DeMarzo and Fishman, 2007; Diamond, 1991) suggesting that a change in firm rating can lead to a switch from one type of debt to another or to other maturities. Their work shows that firms increase their reliance on many different instruments as credit quality deteriorates (Rauh and Sufi, 2010). Their paper is an important foundation for anyone investigating the debt financing decisions of firms.

Contrary to Rauh and Sufi (2010), Colla et al. (Colla et al., 2013) document another phenomenon which they call *debt specialisation*. In a sample of public US firms they show how 85% rely primarily on one type of debt and opposite to Rauh and Sufi (2010) they find that larger, rated firms tend to diversify across more types of debt relative to smaller, unrated firms. Since they use a more comprehensive sample they argue that results using only rated firms are unrepresentative. Using the Compustat Capital IQ database they decompose debt into seven components[8]. In their sample a majority of firms (approximately 66%) rely only on senior bonds and notes for their debt financing.

In their study debt specialisation is measured using a Herfindahl-Hirschman index equalling one if a firm relies solely on one type of debt and zero if the firm uses all seven debt types in equal proportions. Alternatively, debt specialisation is defined for firms who use one type of debt for at least 90% of its debt financing. Using a cluster analysis approach they create five clusters of firms who specialise in one type of debt and one in which firms diversify their debt structure. While their findings for debt heterogeneity are at odds with Rauh and Sufi (2010) they do not find a monotonic relationship in the opposite direction meaning that firms in the middle of the rating spectrum have the highest specialisation of their debt structure (Colla et al., 2013). Using firm characteristics typically employed in leverage studies they find

the traditional trade-off theory in favour of the pecking order (Rajan and Zingales, 1995)

[8]The seven categories are 1) Commercial paper, 2) Drawn credit lines, 3) Term loans, 4) Sen. bonds and notes, 5) Sub. bonds and notes, 6) Capital leases and 7) Other debt

that debt specialisation is negatively correlated with size, profitability, tangibility, dividends, leverage and having a credit rating while it is positively correlated with growth opportunities, cash holdings, R&D expenses and cash flow volatility. They relate these findings to the notion of expected bankruptcy costs and state that firms with high expected bankruptcy should specialise more to avoid multiple costly renegotiations while lower expected bankruptcy costs justify a more diversified debt structure. This explanation is in line with earlier work (Bolton and Scharfstein, 1996).

Also in line with earlier work focusing on the effect of monitoring (Diamond, 1991; Park, 2000) the results suggest that specialisation should be more prevalent among firms with higher information asymmetries i.e. facing higher costs of information collection. The higher the specialisation the more incentive debtholders have to undertake monitoring. Furthermore, their results are consistent with the work of Faulkender and Petersen (2006) in that firms with better credit rating would have access to more and better debt instruments and thus should have lower debt specialisation. One important caveat of both the study by Colla et al. (2013) and the one by Rauh and Sufi is that their results are purely cross-sectional. As documented by Lemmon et al. (2008) a lot of variation is lost by looking only at the cross-section. Thus, the persistence of either debt heterogeneity or debt specialisation over time is an important feature missing.

In line with their earlier work Halling et al. (2020) investigate the use of various debt sources over time and establishing the link between debt heterogeneity and the business cycle. Similarly to Colla et al. (2013) they use the debt categories from capital IQ and construct a Herfindahl-Hirschman index. They find that debt specialisation tends to be pro-cyclical i.e. firms diversify their debt structures more in recessions. This result is, however, not uniform across firms and especially low-leverage firms (i.e. growth firms) appear to be relatively more sensitive to the business cycle and through that increase their concentration and decrease their leverage even more in recessions. Furthermore, they find that market debt and bank debt seem to move in opposite directions. The established counter-cyclicality of debt (Halling et al., 2016) seems to be true for bank debt whereas the reliance on market debt decreases in recessions. This finding is related to the notion of the flexibility of bank debt in bad times

(Diamond, 1984). They expand on the findings of Denis and Mihov (2003) by showing that firms with credit ratings only rely more on market debt in expansions and that this result does not hold in recessions.

Perhaps most striking is that their results seem to be consistent with the otherwise at odds findings of Rauh and Sufi (2010) and Colla et al. (2013). The first paper argues that riskier firms are more diversified. If one assumes that riskier firms become even more risky during a recession then the results of Rauh and Sufi (2010) are consistent with the pro-cyclical debt specialisation found by Halling et al. (2020). On the other hand, Colla et al. (2013) show that firms with higher cost of bankruptcy and lower access to debt markets tend to specialise more. This would suggest counter-cyclical debt specialisation as bankruptcy costs are expected to increase during a recession. This is found to be true for firms with less tangible assets and more growth options, although the pro-cyclical dynamic seems to dominate. Their paper highlights the fact that previous work might not be as contradictory as previously perceived (Halling et al., 2020).

## 3.2 Green Bonds in the Literature

The relative novelty of green bonds means that the accompanying academic literature is still at a state of infancy. Nevertheless, the impact of green investments has been discussed by academics for several years. Early work by Heinkel et al. (2001) investigates this at a high level. Without considering specific green investments or particular investor motives they develop a model demonstrating that the presence of green preferences among investors can alter firm behavior. As more investors require *clean* actions by firms, risk sharing dynamics in the economy are impacted resulting in lower share prices of firms unwilling to change their investment technology. The price differential between firms accepting and unaccepting of investor preferences is growing in the ratio of green investors. When it becomes too great, polluting firms will be forced to change their technology at a cost. Their model also shows how the average cost of capital in the economy is non-monotonic in the ratio of green investors, peaking when the investor universe is split *50/50* (Heinkel et al., 2001).

Specific to the green bond academic literature has also been the notion of a *cost of capital* argument, investigating whether green bonds are issued at a so-called *greenium* i.e. firms issuing green bonds are able to obtain debt financing at favourable terms compared to conventional bonds (Flammer, 2021; Baker et al., 2018). While the pricing of green bonds is by far the most investigated aspect of this new debt class other motives for corporate issuance exist and will be elaborated upon below.

*Signalling*

Flammer (2021) finds that the issuance of a green bond serves to alleviate the asymmetric information between the issuer and the investors. The issuer can credibly signal their commitment to a sustainable and environmentally friendly agenda. This signal is of value as it allows investors to distinguish between corporations, which only perform green washing and those that actually act in environmentally friendly ways. Credibility of the signal follows from the observation that the issuer restricts themselves by issuing a green bond since the proceeds have to be dedicated to specific types of projects. Furthermore, as the green bond market becomes increasingly formalised the issuance of such bonds needs to be verified and monitored by independent third parties. In general, issuing a green rather than a conventional bond is associated with higher upfront costs and reputation risks should the issuer not be able to implement the environmentally friendly mandate (Tang and Zhang, 2020).

In line with the credible signal hypothesis, evidence indicates that the environmental performance of green bond issuers ameliorates post issuance. Flammer (2021) finds that firms issuing green bonds perform better on some key indicators for environmental impact once the green debt has been issued. She also argues that this is likely not due to the green debt instrument alone, as the bond issuances are usually small in comparison to a firm's overall portfolio of projects. Therefore, taking on green debt can be interpreted as a credible signal to commit to a environmentally friendly agenda.

*Investor Value*

The literature shows mixed findings on the premiums associated with green bonds. The premium on bonds is measured by the credit spread i.e. the yield of a particular bond relative to that of a risk-free bond. One argument for the *greenium* is that firms that are more socially

responsible and invest more environmentally friendly are inherently less risky. This view is, however, disputed in the literature (see Menz, 2010; Stellner et al., 2015) and as such higher bonds prices should be evidence of investors willing to accept lower returns from sustainable investments. In line with the findings of Menz (2010) suggesting that more socially responsible firms actually have higher credit spreads, Karpf and Mandel (2018) find a green bond discount of approximately 8 basis points. On the other hand, Baker et al. (2018) find that green municipal bonds trade at a premium after accounting for tax effects (6 basis points) and Tang and Zhang (2020) find similar evidence in a broader dataset. They also conclude that the cost of capital benefits of a green issuance are not significant after accounting for firm fixed effects. Other studies identify a green bond premium of varying significance (Zerbib, 2019; Nanayakkara and Colombage, 2019). Zerbib (2019) finds a small premium, but concludes it is too small to drive firm motives related to valuation. A more interesting result for future research is the expansion of the firms' investor base. Common for all these studies is that none focus solely on corporate bonds. In fact in most samples corporate bonds constitute a relatively small fraction.

Flammer (2021) on the other hand focuses solely on corporate bonds and does not find evidence of a green bond premium. Using the methodology of another study (see Larcker and Watts, 2020) she matches green bonds with conventional bonds from the same issuer using the *Mahalanobis* [9] distance measure [10]. The difference is economically as well as statistically insignificant and Flammer finds this to be consistent with market participants not being willing to accept lower returns despite higher social benefits. As noted by Flammer (2021), studies investigating the pricing of green bonds are limited by the availability of data as total issuance remain a small fraction of the entire bond market. Thus, as more observations become available a clearer picture might present itself. The lack of of a clear financing argument is, nevertheless, consistent with earlier work suggesting that cost of capital is primarily impacted by environmental factors for firms who perform poorly on the subject (Chava, 2014).

[9] The Mahalanobis distance, $\delta$, between green bond $i$ and brown bond j is defined as: $\delta = [(X_i - X_j)\sum^{-1}(X_i - X_j)]^{1/2}$, where X is a vector containing the matching variables and $\sum$ is the covariance matrix.

[10] The bond characteristics used are 1) log(issuance amount) 2) maturity 3) coupon and 4) days between issuance

As Flammer's (2021) data indicates green bond issuers are typically doing better across the three ESG measures and as such should not expect a lower cost of capital.

The early stage of the green bond literature also mean that theoretical work is missing to a greater extend than other areas of corporate finance. One paper by Agliardi and Agliardi (2019) develops a structural model for green bonds and attempts to explain their pricing. Their model builds on classical work (see Leland, 1994, 1998), but incorporates a penalty on corporate earnings which can be alleviated through a green investment. Green bond value depends on traditional factors such as asset volatility and the tax rate as well as new parameters governing the effectiveness of the green technology. The model predicts that a green label will result in improved credit quality and lower cost of capital. Thus the default boundary for green bonds is lower compared to conventional bonds (Agliardi and Agliardi, 2019).

Despite no significant findings related to green bonds themselves, Flammer (2021) finds a positive impact from corporate bond issuance on stock returns. In an event study she examines the stock price reaction of a green bond issuer upon announcement of a green bond issuance. For various event windows the cumulative abnormal return (CAR)[11] of a firm's stock is calculated. For the window [-5, 10] a positive CAR of 0.49% is found at the 5% significance level. The pecking order suggests that bond issuance is met with little reaction from the stock market (Myers and Majluf, 1984) and Flammer (2021) concludes that the positive reaction is likely due to the environmental commitment embedded in the green bond. This argument is further supported by the findings that the result is strongest for first-time green bond issuers and only significant for verified green bonds. As Flammer (2021) in her paper rejects the cost of capital argument these findings points towards a signalling argument.
Similar results are produced by Tang and Zhang (2020) who also find that green bond issuers experience significant abnormal returns around their announcement of a green bond issuance. Like Flammer (2021) they also reject the argument of cheaper financing. Their findings support what they define as the *investor attention* channel as issuance of green bond leads to higher institutional ownership and higher stock liquidity. They, therefore, conclude that green

[11]The CAR is defined as: $AR_{it} = R_{it} - \hat{R}_{it}$, where $\hat{R}_{it}$ is the estimated return on a given day using a market model (OLS)

bonds can serve as a tool for firms to enlarge their investor base as the media exposure increases and certain investors can now fulfil their green mandate through the firm (Tang and Zhang, 2020). Again the notion of first-time issuers is important as results are strongest for this part of the sample. This further indicates the signalling value of a green bond and links this new debt instrument to more classic literature (see Ross, 1977), but also expands on the literature linking corporate social responsibility to stock markets (Krüger, 2015).

In another study Reboredo and Ugolini (2020) investigate the price spillover effects of green bonds on a wide range of financial instruments. They find that green bonds are closely linked to both global treasuries and USD currency markets, but with green bonds being primarily the receivers of the price spillovers. More two-way is the relationship between green bonds and corporate bonds and in relation to the stock market they find only a weak relation. The weak price spillover to equity markets is not necessarily contradicting the findings of Flammer (2021) and Tang and Zhang (2020) as their studies are at a firm level whereas Reboredo and Ugolini (2020) investigate at the market level. Overall their conclusion from a bond issuer perspective is similar to that of other papers. Green bonds are a robust financial instrument which can diversify the investor base of corporations (Reboredo and Ugolini, 2020).

*Ownership*

After establishing a relationship between green bond issuance and stock returns, Flammer (2021) examines the underlying ownership structure of green bond issuers. Here she finds two distinct results. Green bond issuers see an increase in 1) long-term investors and 2) green investors post issuance. Similar to the findings concerning stock returns, the impact of a green bond is only significant for verified green bonds. Thus for long-term or green investors to find additional appeal in a firm's green agenda the signal has to be credible. Flammer (2021) finds no significant relationship for institutional investors, but such a relationship is found by Tang and Zhang (2020) who document a 7.9% increase in institutional ownership post issuance. The increase comes mainly from domestic institutions and is offset by a decrease in the holdings of hedge funds.

Ownership of green bonds appear to be more concentrated, meaning that a subset of investors is willing to buy into these bonds and hold on to them because they are demonstrably associ-

ated with environmentally friendly projects. This concentration becomes even more significant for smaller and lower risk green bonds, since these particular instruments would not significantly affect the total risk in a given investor's portfolio (Baker et al., 2018). Again the effect is stronger for certified green bonds.

*Impact*

Generally, the literature indicates that the emergence of corporate green bonds serves as an opportunity for firms to solidify their green agenda to the market in a credible manner (Flammer, 2021) as well as diversify their investor base by attracting investors with stronger non-economic motives (MacAskill et al., 2020). The finance literature does, at this stage, not seem particularly interested in the impact of green bonds on firm behavior. Flammer (2021) is the only one who, to our knowledge, investigates this issue. She finds that the environmental performance of green bond issuers improves drastically post issuance. On one side the environmental rating of the firm[12] increases by approximately 9%, but more tangible is the overall reduction in $CO_2$ emissions which Flammer finds to be just under 13%. These results first and foremost strengthen the signalling argument and serve to reject the notion of potential *green washing* by firms. Naturally, such an effect does not happen over night and Flammer (2021) finds the effect to materialise two years post issuance. Nevertheless, the magnitude of the emissions reduction is massive and underlines the importance of green bonds as a financial instrument.

The early work on green bonds and in particular corporate green bonds leave many avenues open for investigation. While pricing has been a natural starting point for many researchers more work will be required in this area as the amount of available data grows. Other paths remain unexplored, especially those connecting corporate green bonds and corporate behavior and in particular corporate capital structure. As highlighted in this literature review, capital structure and debt financing decisions of firms are major topics within corporate finance. As data suggests green bonds will become more and more prevalent this thesis serves to establish and initial connection between this newly emerging financial instrument and one of the most classical topics in finance.

[12]Flammer relies on the ESG ratings provided by ASSET4

# 4 Data

Attempting to answer a research question using empirical methods requires data. This section introduces how we have gathered as well as handled all relevant data, for the analysis presented in section 7, in section 4.1 and 4.4 respectively. In empirical research there is rarely one way of defining certain metrics or control variables. We therefore discuss alternative formulations in relation to the selected definitions of section 4.2 and 4.3.

## 4.1 Sample Construction

For the subsequent analysis a panel data sample of publicly listed firms is constructed. The aim is to compare those firms with access to green capital markets to a representative sample of other corporate bond issuers. As the first corporate green bond was issued in 2013, this is also the beginning of the panel data. At the time of writing some data points for 2020 are not available through the Wharton Research Data Service and thus the panel ends in the fourth quarter of 2019.

The sample of green bond issuing firms is constructed using Bloomberg's Fixed Income database found through the "SRCH" command. The database contains detailed information on bond issues including a Green Debt Instrument Indicator variable. Through this database information such as issue amounts, announcement dates, issue dates and issuer is collected. By filtering for only those securities, which have been tagged by Bloomberg as "green" the entire sample of global green bond issues is collected. Following Flammer (2021) we exclude all bonds for which the issuer is labeled as 'government'. Bloomberg uses a proprietary method to assess whether any given fixed income security constitutes a green bond since there is no unified way of classifying the green bond label.

In accordance with the argumentation of Flammer (2021) Bloomberg's sample of green bond issues should represent the large majority of overall green bonds in the market and should thus allow us to identify the issuing firms with a high degree of accuracy. To construct the green bond indicator variable for the panel data, the date of issuance is retrieved from Bloomberg as well. To determine the specific issuing firm, the equity ticker corresponding to the issuing

entity of the green bond is collected. This metric is important for linking Bloomberg's data with other datasets as elaborated upon below.

As we are interested in the unique effect of green bond issuance on firm leverage we construct a control sample representative of the general corporate bond environment. Since Bloomberg's data limits make it infeasible to use the same method as outlined above for the representative sample, the sample is built through other datasets in the Wharton Research Data Service environment. Specifically, two different methods are used to collect data and construct a North American and an international sample. This is due to the fact that Standard & Poor's Compustat has split its data repository into a North America and Global data bank and thus requires two separate queries. For the North American subset a total database search on FISD Mergent's data reports the universe of traded corporate bonds in the US. Through the issuer CUSIP[13] variable the corresponding issuers can be identified. The CUSIP acts as a unique identifier for each security within the Compustat repository. The main difficulty is that these issuer CUSIPs only contain the first 6 digits of the entire 9-digit CUSIP, which would be needed in order to retrieve data from Compustat. The first 6 digits represent the issuer of the security, whereas the following 3 digits identify the specific security being searched for. Thus, debt and equity instruments issued by the same entity will have the same first 6 digits, but the final 3 will differ for each financial instrument issued. For such purposes the Center for Research in Security Prices (CRSP) contains tools to convert 6 digit CUSIPs into other identifiers. For our purpose we extract the corresponding equity tickers as this allows us to link the Compustat output to Bloomberg.

For the construction of the international sample we refer to the Capital IQ - Capital Structure Debt repository. This segment within Compustat provides detailed information on the capital structure of global firms. The different segments of debt are categorised by the *'capitalStructureSubTydeId'* variable. We perform an entire database query and extract the entire universe of firms recorded within the Capital IQ environment. Subsequently, by filtering the *'capitalStructureSubTydeId'* variable for those firms which have debt in category 4 or "Bonds & Notes" we reduce the sample to only those firms which have issued bonds. From this output

[13]Committee on Uniform Securities Identification Procedures

the *gvkey* for each of the firms can be extracted as a means to link the Capital IQ - Capital Structure Debt data to other Compustat repositories. The gvkey is a company unique identifier used within the Compustat environments. In order to limit the holes within our dataset and to assure that the subsequent panel is as balanced as possible we limit the sample to firms that have their operations in the EU, Great Britain, the Nordic countries or Japan. While the scope of this sample is largely built around considerations of data availability and data handling it in large part coincides with the sample countries used by Rajan and Zingales (1995). Unfortunately, this means that China is excluded from the international sample, which contains an increasing number of green bond issuers. The accounting data for the analysis is collected from Compustat - Capital IQ. As outlined below several different variables are accessed through the Wharton Research Data Services.

For the construction of the North American sample the North America - Daily - Fundamentals datasets contain both annual and quarterly data for the issuer firms. All outputs are reported in USD. As a query reference we use the company tickers as obtained through FISD Mergent and CRSP. For the international sample we access the Global - Daily dataset using the gvkeys collected from the Capital Structure Debt database. A difficulty within the international sample is linking the Compustat output to Bloomberg as Compustat does not report equity tickers for that segment of its environment. We therefore use the legal company names as a link between the two datasets. Furthermore, Compustat - Global - Daily - Fundamentals does not report data on outstanding shares and prices for each fiscal year as the North American Fundamentals search does. We require this information for the calculation of the market values of our sample firms. For this reason, we perform an additional query on the Securities Daily subset in order to extract daily information on the closing prices and outstanding shares for our sample. By using the gvkey and the date of the observed data as a link we then merge the prices and outstanding shares information with the accounting data for the international sample. Following this procedure we end up with two representative samples. The North American and international sample consist of 967 and 1,766 unique firms respectively, but not all firms have accounting data for the full sample period.

## 4.2 Dependent Variables

Throughout section 7 we perform regression analysis with the objective of establishing association between green bond issuance and firms' financing behavior. We first examine potential differences in overall leverage for the two samples and move on to an investigation of the impact of green bonds on the debt structure of firms. Here the focus will be on maturity composition as well as debt specialisation. For each of these three analysis we need a dependent variable, with the same independent variables being used across all analysis. The construction of the different dependent variables will be elaborated upon below and the specific Compustat accounts used for computation are referenced in parenthesis.

### 4.2.1 Leverage

As this paper investigates the debt financing decisions of firms a key variable of interest is leverage. Despite the extensive empirical literature there is, as noted by Welch (2011), no universal definition of leverage and as a result there is some variation when it comes to defining firm leverage. A logical starting point would be to take the ratio of *total liabilities* to *total assets*. The rationale is that this ratio conveys how much is left to shareholders in case of bankruptcy. The major drawback is that the liability section of a firm's balance sheet consists of much more than debt. Items unrelated to a firm's financing decision are included in this measure and therefore the true leverage of a firm will be overstated.

Two measures that are used extensively are *book leverage* and *market leverage*[14]. The book leverage is defined as a firm's short (DLCQ) and long-term debt (DLTTQ) divided by the book value of its assets (ATQ). Even though book leverage is frequently reported in the literature (Rajan and Zingales, 1995; Frank and Goyal, 2009; Rauh and Sufi, 2010) it does has its drawbacks. Generally, a firm's actual equity value will not match the value reported on its balance sheet and thus any leverage ratio using book values risk misreporting a firm's true leverage if the discrepancy of book and market equity is substantial. Typically, researchers adjust the book value of assets by subtracting the reported book value of equity (TEQQ) and replacing it with the market value (Faulkender and Petersen, 2006).

[14] Also sometimes referred to as quasi-market leverage since debt is still taken at book value

$$\text{MV Assets} = \text{BV Assets} - \text{BV Equity} + \text{MV Equity}$$

Using Compustat data the market value a equity is found by multiplying the closing price of a firm's stock (PRCCQ) with the number of outstanding shares (CSHOQ). We follow this definition in our analysis despite Welch (2011) arguing that this leverage ratio essentially counts non-financial liabilities as equity and thereby understates the true leverage of the firm. He thus argues going back to the previously mentioned leverage ratio in which all liabilities are accounted for. The main reason for our choice of leverage ratio is the extensive use in the literature which facilitates much easier comparison between our results and influential papers. An argument could also be made for the use of *net leverage* i.e. a leverage ratio in which the cash holdings of a firm are subtracted from its total debt. Firms can differ substantially in the amount of cash held on their balance sheet (Opler et al., 1999) and firms with large cash holdings can more easily pay off their debt. Net leverage removes this variation across firms and a more direct comparison of firms can be made. Despite this benefit net leverage is rarely used as the main dependent variable and will not be considered further in this paper.

### 4.2.2 Short vs. Long-term Debt

Another interesting aspect of firms' decision to use green bonds in their capital structure is how it affects the composition of its debt. More specifically we investigate whether green bond issuance impacts short or long-term leverage. This distinction is less common in traditional capital structure, however, Faulkender and Petersen (2006) do run their regression for a long-term debt specification. In their study of the determinants of corporate debt maturity Barclay and Smith (1995) uses the percentage of debt maturing in more than three years as their dependent variable. A similar approach is taken by Billett et al. (2007) although their focus is on the short-term component. Stohs and Mauer (1996) construct an average maturity for their empirical study of corporate debt maturity. One important distinguishing feature in their model is that they include all current liabilities, since they argue that they in many ways are analogous to short-term debt.

Ideally, to obtain a sophisticated measure for maturity one would utilise the reported maturities from Compustat Capital IQ. Unfortunately, the data is not available for all securities. For this analysis we therefore rely on the information provided by Compustat, which reports balance sheet items at a higher level. We follow the approach of Barclay and Smith (1995) as well as Billett in al. (2007) as we only consider firm debt and not other current liabilities. We define short-term debt as all debt within current liabilities (DLCQ) and long-term debt is all non-current debt (DLTTQ). For our investigation of short and long-term leverage we again follow Faulkender and Petersen (2006) and scale the values by the market value of total assets. Secondly, to further examine the relationship within the corporate debt structure we scale both measures by total debt (DLCQ + DLTTQ).

We recognise that these measures are not truly reflecting the more granular dispersion of the corporate maturity profile of firms. For our purposes and with the data which is readily available they will nonetheless allows us to establish association between the use of corporate green bonds and the maturity considerations taken by firms.

### 4.2.3 Specialisation

For our analysis of debt heterogeneity we follow the approach taken by Colla et al. (2013) and Halling et al. (2020). Both papers utilise the debt structure feature of Compustat - Capital IQ and constructs a Herfindahl-Hircschman Index (HHI). The distinct debt components reported in Capital IQ are 1) Commercial Paper, 2) Revolving Credit, 3) Term Loans, 4) Bonds and Notes, 5) Capital Leases,[15], 6) Trust Preferred[16] and 7) Other Borrowings[17].

The computation of the HHI follows a two step procedure. First, each of the seven debt structure components are weighted by the total debt which in turn is squared.

$$SS_{i,t} = \left(\frac{CP_{i,t}}{TD_{i,t}}\right)^2 + \left(\frac{RC_{i,t}}{TD_{i,t}}\right)^2 + \left(\frac{TL_{i,t}}{TD_{i,t}}\right)^2 + \left(\frac{BN_{i,t}}{TD_{i,t}}\right)^2 + \left(\frac{CL_{i,t}}{TD_{i,t}}\right)^2 + \left(\frac{TP_{i,t}}{TD_{i,t}}\right)^2 + \left(\frac{Other_{i,t}}{TD_{i,t}}\right)^2$$

[15] Capital leases are reported as both an asset and a liability on the company's balance sheet (unlike operating leases)

[16] Special type of security typically issued by a bank. Investors can purchase shares in a trust set up by the company. The trust is funded by debt and the shares relate only to the trust and not ownership in the overall company.

[17] Typically short-term borrowings (Colla et al., 2013)

The sum of these seven squared figures is then used for the calculation resulting in the HHI measure of debt structure specialisation:

$$HHI_{i,t} = \frac{SS_{i,t} - 1/7}{1 - 1/7}$$

Since the sum of squares will never exceed 1, so is the HHI bounded by 0 and 1. If a firm relies exclusively on one type of debt the index will be equal to 1 whereas if a firm has a perfectly balanced debt structure the index will be 0.

An alternative measure of specialisation is used by Colla et al. (2013). They construct a dummy variable equal to 1 for firms which have more than 90% of their debt coming from one of the seven debt structure components and 0 otherwise. Since their conclusions are unchanged for the two measures we focus on the first one.

## 4.3 Independent Variables

**Tangible Assets**

All else equal a higher amount of tangible assets should allow a company to take on more debt. This theoretical conclusion is based on the observation that the tangible assets can act as easily available collateral making lenders more willing to extend debt (Titman and Wessels, 1988). In order to account for the degree of tangibility the ratio of tangible assets to total assets is used. Within Compustat the variable property, plant and equipment (PPEGTQ) provides a measure of the tangible assets on a firm's balance sheet (Rajan and Zingales, 1995). Following the literature we scale the measure of PP&E by the book value of total assets (Colla et al., 2013; Faulkender and Petersen, 2006). In their study of capital structure determinants Frank and Goyal (2009) find tangibility to be among the more reliable factors. They follow the definition mentioned above, but also proxy the nature a firm's assets by its R&D and SG&A expenditures arguing firms with high discretionary spending tend to have more intangible assets.

### Growth Opportunities

Throughout the academic literature the growth opportunities of firms have consistently been proxied by the market-to-book ratio (M/B) (Rajan and Zingales, 1995; Frank and Goyal, 2009; Colla et al., 2013). It describes the relationship between the market and book value of a firm's assets and a higher ratio is an indication of more growth opportunities for the firm as capital markets value its assets more than their original value. The key component is the market value of assets. Just like with the leverage ratio we again follow the definition used by Faulkender and Petersen (2006). Other papers e.g. by Frank and Goyal (2009) and Colla et al. (2013) compute the market value of assets slightly different by accounting for the liquidation value of preferred equity and deferred tax and investment credits. As the market value of a firm to a large extend is driven by market expectations through equity value, one could argue that the M/B ratio more signal the perceived growth potential rather than the actual growth opportunities of a firm. If a firm actively invests more this would also indicate more growth opportunities (Titman and Wessels, 1988). Thus, the capital expenditure of a firm can be used as a proxy for growth. Since this directly influences the flow of funds deficit (Shyam-Sunder and Myers, 1999) Frank and Goyal (2009) argue that this proxy should be positively correlated with debt according to the pecking order theory. In their study, they find that the M/B ratio is a more reliable determinant of capital structure and we therefore do not include capital expenditure as a control.

### Profitability

Normally, when considering the profitability of firms one would look at net income as a fraction of total sales. Since this measure is heavily influenced by the interest payments of firms, the academic literature relies on operating income before depreciation i.e. *EBITDA*. While Rauh and Sufi (2010) use operating income after depreciation (EBIT) this measure has the drawback that firms with varying depreciation expenses will report vastly different operating income. Since most tangible assets (except land) are subject to depreciation, but some intangible assets (e.g. goodwill) are only subject to impairment checks, firms with a very tangible asset base will report very different EBITDA and EBIT figures (Robinson, 2020). Thus for easier comparison EBITDA is preferred in the literature (Frank and Goyal, 2009; Rajan and Zingales, 1995; Chang and Dasgupta, 2009). As is also standard practice, we scale the operating income

before depreciation (OIBDPQ). Frank and Goyal (2009), Colla et al. (Colla et al., 2013) as well as Rajan and Zingales (1995) all scale operating income by book value of assets (ATQ). Following Faulkender and Petersen (2006) we scale by total sales (SALEQ). Titman and Wessel (1988) consider both variations and find no material difference in magnitude or significance.

**Size**

As found by Frank and Goyal (2009), firm size is among the most reliable factors in determining firm capital structure. Generally, the literature defines size in one of two ways. One stream of papers (Frank and Goyal, 2009; Colla et al., 2013) define it as the logarithm of a firm's total assets (book value). On the other hand, some papers use the logarithm of firm sales as a proxy for its size (Rajan and Zingales, 1995; Rauh and Sufi, 2010; Titman and Wessels, 1988). The sales based proxy does have the drawback that firms in some quarters will report lower sales than usual due to unforeseen circumstances. Here the asset based measure will be more consistent. The decision to take the logarithm comes from Titman and Wessel (1988) as they hypothesise the size effect on leverage to be more present for smaller firms.

Faulkender and Petersen (2006) use the natural logarithm of a firm's assets at market value. Again this measure might be less consistent as a firm's market value fluctuates with its stock price. Since our methodology is closest to theirs we follow this definition of size. We test the validity of our choice by using the two alternative measures and find no significant change to our conclusions. Some papers also proxy firm size by their age (Faulkender and Petersen, 2006). The magnitude of this proxy is, however, very small and Frank and Goyal (2009) also conclude the asset based proxy to be more reliable.

**Uniqueness**

The research and development expenditure of firms is typically used as a proxy for either growth or the uniqueness of its products (Titman and Wessels, 1988; Frank and Goyal, 2009). Following the wide consensus in the literature we scale R&D expense as reported in Compustat (XRDQ) by total sales (SALEQ) (Faulkender and Petersen, 2006). Due to data limitations this variable is only constructe for the North American sample.

In addition to R&D several studies use SG&A expenditure to proxy for uniquenss or intangible assets (Titman and Wessels, 1988; Faulkender and Petersen, 2006; Leary and Roberts,

2005). The key interest here is the firm's advertising/selling expenses. This expenditure is not readily available on its own, but is in Compustat grouped with other administrative expenses (XSGAQ). Despite this drawback we include SG&A scaled by total sales as a control.

**Short-term Debt**

Following Faulkender and Petersen (2006) we control for firms' reliance on short-term debt. Our measure is the fraction of short-term debt (DLCQ) to total debt (DLCQ + DLTTQ). The theoretical justification for its inclusion comes from Myers (1977) who argues that one possible solution to the agency cost related to debt overhang is to shorten the maturity of debt. Thus if a firm is relying more heavily on short-term debt one would expect it to have lower leverage *ceteris paribus*.

**Volatility**

The volatility of a firm can influence its leverage decision as more volatile firms are expected to have higher costs of financial distress (Frank and Goyal, 2009). Taking the approach of Faulkender and Petersen (2006) we proxy this firm characteristic by the volatility of equity multiplied by the equity-to-asset ratio of the firm. Since we use quarterly data we calculate the standard deviation using the stock return for the past eight quarters. Equity returns are calculated using the closing share price (PRCCQ). As in Faulkender and Petersen (2006) using scaled equity volatility will understate the true volatility of a firm's assets if it also has debt financing[18].

There is little consensus in the literature on defining volatility. Colla et al. (2013) use the standard deviation of the firm's operating income as proxy for volatility, Leary and Roberts (2005) take the absolute change in the firm's net income and Frank and Goyal (2009) use the variance of the firm's stock returns. Titman and Wessel (1988) argue that the only variable correctly reflecting the earnings volatility of the firm is the standard deviation of the percentage change in operating income.

[18]The correct formula for assets volatility is: $\sigma_A = \sqrt{(\frac{E}{A})^2\sigma_E^2 + (\frac{D}{A})^2\sigma_D^2 + 2(\frac{D}{A})(\frac{E}{A})\rho\sigma_D\sigma_E}$

**Return on Equity**

Especially when examining market leverage the return on equity has big implications. Welch (2004) calls stock returns the "*only well understood influence of debt ratio dynamics*" and claim they can explain as much as 40% of capital structure variation. Faulkender and Petersen (2006) thus include the stock return of the previous year as an explanatory variable. Following their example we include the return of a company's stock over the previous year. Their exact methodology for computing the annual return is not stated, so we follow Leary and Roberts (2005) who define equity return as the cumulative return of the company's stock over the past four quarters.

Frank and Goyal (2009) also use the cumulative stock return, but uses a monthly frequency. Comparing Frank and Goyal (2009) with Faulkender and Petersen (2006), despite the two studies calculating stock return differently they reach the same conclusion. Thus, we maintain the appropriateness of using cumulative stock returns to account for return on equity.

**Green Bond Indicator**

Using the data obtained through Bloomberg's fixed income database we construct a indicator variable which measures if a firm has issued a green bond in a given quarter. Specifically, the indicator switches from 0 to 1 in the time period the green bond has been issued. The construction of the green bond indicator highlights the key benefits of using quarterly rather than annual data. If for instance a firm issues a green bond in the second quarter of 2018, using quarterly data gives us seven 'green bond observations' rather than two. Secondly, by not relying on annual data we reduce the risk of having other leverage decisions distort the green bond effect (Ham et al., 2020). Again, if a green bond is issued in the second quarter of 2018, by using quarterly data we track the change in debt much closer compared to annual data. The firm might decide to alter its leverage ratio in the fourth quarter of the same year and this will affect the effect of a green bond observation if relying on annual data.

The purpose of the green bond indicator is to measure which firms have the capabilities to issue on the newly emerging sustainable capital markets and can thus make use of this increase in debt supply.

It is important to note that the sample of green bond issuers is still rather small compared to the total environment of corporate bond issuers. Additionally, since issues have increased

rapidly in recent years, the green bond indicator is largely 0 for the years 2013 - 2015. This lack of observations can impact the statistical significance of the regression analysis.

## 4.4 Winsorizing and Data Handling

An important consideration for the following regression analysis is the handling of extreme outliers. Such observations can fundamentally change the inference made on the estimation outputs and can bias any results as they obscure the underlying deterministic relationship between the variables of interest. We follow the rationale in traditional empirical corporate finance literature and evaluate the data for such extreme outliers so as to assure that the potential for biases occurring is minimised. An example of such an outlier follows from the specific accounting practices in the US and the introduction of impairment charges into the profit and loss statements.

For instance, within our sample we have identified the firm Goodrich Petroleum, which has faced substantial impairment write offs of 452 USDm in 2014 and 332 USDm in 2015 as reported in their 2015 financial statements, which significantly affected the firms profitability. Accounting practices dictate that such losses are reflected in the operational performance of the firm which in this case creates unrealistic metrics for profitability. The problem arises because extreme outliers misrepresent the actual operational performance of the firm and in turn can have a statistically significant impact on any analysis. To minimise the effect of such idiosyncratic events we winsorize the firm characteristics and supplement that with a series of robustness checks.

Following Colla et al. (2013) we firstly exclude all firms for which Compustat does not report asset values or which have an asset value of zero. We also exclude all firms for which have missing observations for total debt. For the international sample we exclude firms for which the Compustat Security Daily database does not report daily equity prices.

After evaluating the outliers within our dataset we find some unrealistic values for several firm metrics. We, therefore, apply the same methodology of winsorizing as Colla et al. (2013) for a subset of variables. Specifically, we winsorize SG&A, R&D, profitability, tangible assets (scaled by book assets), implied asset volatility and return on equity. We winsorize the data at

the 1st and 99th percentile. Finally, we observe that a part of our sample has a book leverage ratio above 1, which stands in contradiction to the definition of book leverage. We follow the methodology of Faulkender and Petersen (2006) and recode the book leverage values to take a maximum value of 1. Subsequently the book leverage values vary between 0 and 1.

# 5 Methodology

To assess the relationship of capital market access and leverage we conduct several iterations of regression analyses and present their outputs in section 7. Section 5.1 elaborates on the fundamental requirements for a regression analysis and statistical implications required for the resulting inferences to be statistically sound. Following this we elaborate on the specific methodologies being used in this thesis in section 5.2. Finally, section 5.3 describes the econometric tests we employ to guide our choice of regression models.

## 5.1 Ordinary Least Squares

An Ordinary Least Squares (OLS) regression analysis allows the assessment of the statistical relationship between the analysed variables. In this case we are interested to determine how the issuance of a green bond will on average affect the leverage of a firm. For the model estimation to be unbiased and consistent the following conditions need to be met (Wooldridge, 2015):

*1. Linearity in Parameters*

Using OLS implies a linear relationship between the variables of interest. In order for such an estimation to be appropriate the underlying relationship between the variables must thus be assumed to be linear.

*2. Random Sample*

In order for the results to be representative of the true population parameters, the data used for the OLS analysis needs to be independently and identically distributed. Essentially, this is an assumption about the sampling of the data, wherein the data sample needs to reflect the characteristics of the total population being analysed.

*3. Exclusion of perfect Multicollinearity*

This assumption precludes perfect correlation between the regressor variables. From a technical standpoint perfect linear correlation between two regressors makes the estimation of the parameters of interest impossible. Thus, this is a necessary assumption to make the OLS estimation mathematically solvable.

*4. Zero Conditional Mean of the Error Term*

Under this assumption the determinants contained in the error term necessarily needs to be uncorrelated with the regressors included in the OLS model. Omitting factors, which are correlated with a regressor and the variable of interest, will cause a bias within the estimated parameters. In order to assure statistically rigorous inference on the estimated parameters the model choice must therefore account for such potential biases through the inclusion of control variables.

*5. Homoskedasticity in the Error Variance*

Having established that the mean of the error term needs to be zero conditional on the regressors in order to avoid a possible bias, similarly the conditional variance of the error term should not be dependent on the regressor values. This concept of homoskedasticity will not bias the estimated parameters it does, however, affect the reported standard errors within the estimation output. Misleading standard errors in turn can cause false inference. Heteroskedasticity can be accounted for in the calculation of the standard errors[19]. The second implication of homoskedasticity in combination with the previously stated assumptions, is that OLS then is the Best Linear Unbiased Estimator (BLUE) as stated by the Gauss Markov theorem.

In order for these assumptions to not be violated an important consideration is the use of independent control variables for an accurate model specification (Wooldridge, 2015). We do not assume that firm leverage is singularly a function of green bond capital market access. To account for other causal determinants of leverage we include the independent variables as outlined in section 4.3. The list of control variables follows from theoretical implications and is comprised on the basis of our literature review.

The core model we build our analysis on, stated as a cross sectional analysis across firms, $i$, is formulated as follows (Rajan and Zingales, 1995):

$$Leverage_i = \alpha + \beta_1 Tangibility_i + \beta_2 Size_i + \beta_3 M/B_i + \beta_4 Profitability_i + \epsilon_i \qquad (1)$$

[19] See appendix 1

Based on the model specification we can already determine that a linear relationship between debt and its determinants is assumed by the model. Existing empirical literature shows that this model specification is largely valid (Rajan and Zingales, 1995). The second assumption is met by the construction of the analysed sample. By gathering data on as many green bond issuers and corporate bond issuers as possible a representative sample of the overall corporate bond environment can reasonably be assumed to have been collected. The regressors do not display perfect multicollinearity and, therefore, assumption 3 is also reasonably met. The final two assumptions are considered through the construction of the subsequent analysis. By including different regressors and control variables we intend to test the robustness of the model indicating whether an omitted variable bias is present for any given specification. Similarly, we perform a Breusch Pagan test on our data to investigate the presence of heteroskedasticity. The outcome of the test informs the subsequent model choice so as to assure the soundness of any statistical inferences made on the basis of the output parameters.

We expand upon the traditional leverage regression model by including additional controls often to be found significant in the literature. The inclusion for the control variables should account for unobserved omitted effects, which should also diminish the probability of a omitted variable bias occurring in our analysis. Furthermore, we construct the green bond indicator variable (section 4.3), which specifies if a green bond has been issued by the observed firm. The purpose of tracking the issuance of green bonds is to identify the firms which have access to the newly emerging sustainable bond market. In its cross sectional specification we then formulate the following model with $X_i$ representing additional control variables such as SG&A and return on equity:

$$Leverage_i = \alpha + \beta_1 Tangibility_i + \beta_2 Size_i + \beta_3 M/B_i + \beta_4 Profitability_i + \beta_5 GB_i + \beta_6 X_i + \epsilon_i \quad (2)$$

## 5.2 Panel Data Regression

Given the granular data collected by Compustat, we can expand upon the cross sectional analysis of the previous section by adding a time dimension. The sample then varies by two indicators the firm, $i$, and the time period $t$. A key benefit of adding the time dimension is to increase the sample size used for estimation. Increasing the sample size should increase the

accuracy of the estimation method as well as increase the precision of the estimation's test statistics (Wooldridge, 2015). It should be noted that the Compustat data files contain missing data points and therefore all subsequent analyses are performed with unbalanced panel data.

Under specific assumptions a regular OLS estimation can be run directly on the pooled cross sectional data. Performing a pooled OLS regression, however, assumes that the cross sectional samples have been drawn at random over several time periods. In this case we follow specific cross sectional entities across several time periods and therefore the conditions for a regular OLS regression are not credibly met. What pooled OLS fails to account for are cross sectional fixed effects, which are firm specific leverage determinants that do not vary over time and are not observable in the data (Stock and Watson, 2015). For this reason, we follow the methodology of Faulkender and Petersen (2006) and employ other panel regression methods. Under the assumption that the cross sectional fixed effects are correlated with the regressors in the model specification we perform a first difference regression and a fixed effects regression. The model specification for the leverage regression including a firm index, $i$, and a time index, $t$, is specified as follows:

$$Leverage_{it} = \alpha + \beta_1 Tangibility_{it} + \beta_2 Size_{it} + \beta_3 M/B_{it} + \beta_4 Profitability_{it} + \beta_5 GB_{it} + \beta_6 X_{it} + \epsilon_{it} \tag{3}$$

The problem arising from the cross sectional fixed effects contained within the error term $\epsilon_{it}$. The error term can be deconstructed into the idiosyncratic error $u_{it}$ and the time constant error $a_i$:

$$\epsilon_{it} = a_i + u_{it} \tag{4}$$

If $a_i$ is a significant determinant of leverage and if it is correlated with the regressors in the model, then the model will suffer an omitted variable bias. Inherently, $a_i$ cannot be accounted for directly, as it is unobserved in the data. Intuitively, it represents all factors specific to any firm, $i$, that causes it to act in an idiosyncratic way.

*First Difference Estimation*

The first method proposed by Wooldridge (2015) to eliminate the effect of $a_i$ is to take the first difference of the data and perform an OLS regression on the differenced data. By transforming

the data in this manner the time fixed effects are factored out of the equation above. For OLS to be unbiased and for the t and F-statistics to be interpretable the regular OLS assumptions have to hold for the differenced data. It is also important to note that the observations for the first time period are lost through the first difference process, but this is only a significant problem if few time periods are available.

*Fixed Effects and Dummy Regression*

The second estimation proposed by Wooldridge (2015) is the fixed effects model. In this specification the mean is calculated for each cross sectional observation across time. These means are then subtracted from the original panel regression equation. The effect of this "time-demeaning" process is that time fixed effects are factored out. Through this process the idiosyncratic error term $a_i$ can have any arbitrary correlation with the regressor variables without it affecting the integrity of the analysis. The classic OLS assumptions still have to hold for the demeaned data. Furthermore, we lose one degree of freedom for each cross sectional observation as we have to account for the mean of each of them. An alternative approach to the demeaned fixed effects estimation is to perform a dummy variable regression on the original panel data. In a dummy variable regression the $a_i$ term is viewed as a parameter that can be estimated for each cross sectional observation by including a dummy for each of them. The resulting coefficients and standard errors are identical to that of the time demeaned regression. The main drawback of the dummy variable regression is that it is cumbersome to compute in practice if the number of cross sectional observations is large as each of the N observations will require a unique indicator variable.

*Tobit Estimation*

For the final part of our analysis we try to understand the statistical relationship between firm characteristics and debt specialisation. Within this model the Herfindahl-Hirschmann Index measures the degree of debt specialisation for each firm. We use this index as a dependent variable in our regression model leading to the following model specification:

$$HHI_{it} = \alpha + \beta_1 Tangibility_{it} + \beta_2 Size_{it} + \beta_3 M/B_{it} + \beta_4 Profitability_{it} + \beta_5 GB_{it} + \beta_6 X_{it} + \epsilon_{it} \tag{5}$$

The classic firm characteristics including the the green bond indicator act as dependent variables just as in the previously specified models. The main difference is the use of the HHI, which creates problems for the previously outlined estimation methods. The HHI index only varies between 0 and 1, however, is continuous within this interval. We cannot anymore assume a monotonous and linear relationship between our regressors and the dependent variable. For this reason we employ the Tobit estimation method for this part of the analysis.

For the Tobit estimation the response variable is assumed to be non-negative, making the lower bound of the prediction interval 0. Additionally, we specify an upper bound to the dependent variable of 1. The Tobit regression is solved using Maximum Likelihood Estimation (MLE). For the MLE estimation the response variable $y$ is modeled using an underlying latent variable $y^*$, wherein $y = max(0, y^*)$. Furthermore, the latent variable is assumed to meet the conditions of the traditional linear regression models: $y^* = \alpha + \beta_1 x_1 + ... + \beta_k x_k + u$, wherein the error term is normally distributed and homoskedastic. Based on these assumptions the likelihood function based on $y^*$ is constructed using the normal density function. Furthermore, the MLE estimation maximises the logarithm of the likelihood function. Interpreting the coefficients from the Tobit regression output is not as straightforward as with OLS. Strictly speaking the coefficients measure the correlation of the regressor variables with the latent variable rather than the actual dependent variable. In order to assess the relationship between the response variable $y$ and the regressors we need to transform the output coefficients using the characteristic that the error term is assumed to be normally distributed. As a result, we find a specification for predicting $y$, which is based on a nonlinear function of the regressors and their parameters. Furthermore, based on the assumptions underlying the Tobit specification the predicted values cannot exceed the limits set for $y$. As we know that the HHI can only vary within the 0 - 1 interval we can employ the Tobit estimation model to analyse the determinants of debt specialisation (Wooldridge, 2015).

## 5.3 Econometric Tests

To test the validity of the above mentioned models we perform a series of statistical tests. Specifically, the specification above makes assumptions based on the cross sectional firm fixed effects, which can be investigated more rigorously through the Breusch Pagan LM test and the Hausman test[20].

*Breusch Pagan LM test for homoskedasticity*

A critical assumption for the pooled OLS regression is homoskedasticity in the error terms. If this condition is not met, the calculated standard errors are incorrect as the model fails to account for the changes in the error variance. Under these circumstances other estimation methods such as random effects or fixed effects should be implemented. We test for this in our regression errors using the Breusch Pagan Test for homoskedasticity. The null hypothesis of the test can be stated as follows: $H_0 : E(u_i^2|x_i) = \sigma^2$, whereas under the alternative hypothesis the error variance changes with different values of $x_i$. Testing this hypothesis can be performed on the residuals of the regression outputs $\hat{u}_i$ as the actual errors are not observable. If significant correlation between the regressors $x_i$ and the residuals $\hat{u}_i$ is found the test rejects the null hypothesis of homoskedasticity. For this purpose a LM-test for joint significance is run on the coefficients of the auxiliary regression in which the residuals of the original pooled OLS specification are the dependent variable, while the regressors $x_i$ are the independent variables. The test statistic $nR^2$ is Chi-squared distributed with k degrees of freedom, where k is the number of independent variables (Wooldridge, 2010).

*Hausman test to determine Random Effects or Fixed Effects*

When choosing between random effects and fixed effects estimation the key determinant is the correlation between the fixed effect $a_i$ and the regressor variables $x_i$. If significant correlation is prevalent the random effects estimations are inconsistent. The Hausman test determines the degree to which the estimated random effects and fixed effects models differ by comparing the estimated coefficients and standard errors (Wooldridge, 2010). The null hypothesis can be stated as: $Cov(x_{it}, a_i) = 0$ .

[20]Conclusions regarding model choice based on the tests presented below can be found in appendix 1

*Serial correlation in the error term $u_{it}$*

Given the standard OLS assumptions hold both fixed effects and first difference estimations are unbiased and consistent. The distinguishing criterion between the two methods is the efficiency of the estimators. In this context efficiency implies that the variance of one of the two unbiased estimators is smaller than the other. This estimator variance depends on the serial correlation within the error term $u_{it}$. Wooldridge (2015) proposes a test performed on the residuals of the first difference model in order to assess the serial correlation within the level model's residuals. The author notes that a lack of serial correlation in the level model specification will cause serial correlation for the first difference error terms. On the other hand, if the error term of the level model follows a random walk then the first difference specification will not display any serial correlation. Therefore, by testing for serial correlation in the error term of the first difference model we can assess whether we find serial correlation in the level model's error. On the basis of this observation we can then proceed to choose between fixed effects estimation and first difference estimation.

# 6 Descriptive Statistics

This section serves as an introduction of the dataset used for the regression analysis conducted in section 7. The description of the data is split into multiple subsections. Section 6.1 describes the green bond universe. It contains all bonds labeled as green in the Bloomberg fixed income universe, with the the exclusion of governmental issuances. Secondly, the firm samples constructed based on the green bond universe are described. For both the North American and international sample, green bond issuers are grouped with conventional bond issuers for comparison. The main characteristics, similarities and differences are elaborated upon in section 6.2. Finally, section 6.3 highlights high-level insight with respect to firm debt specialisation.

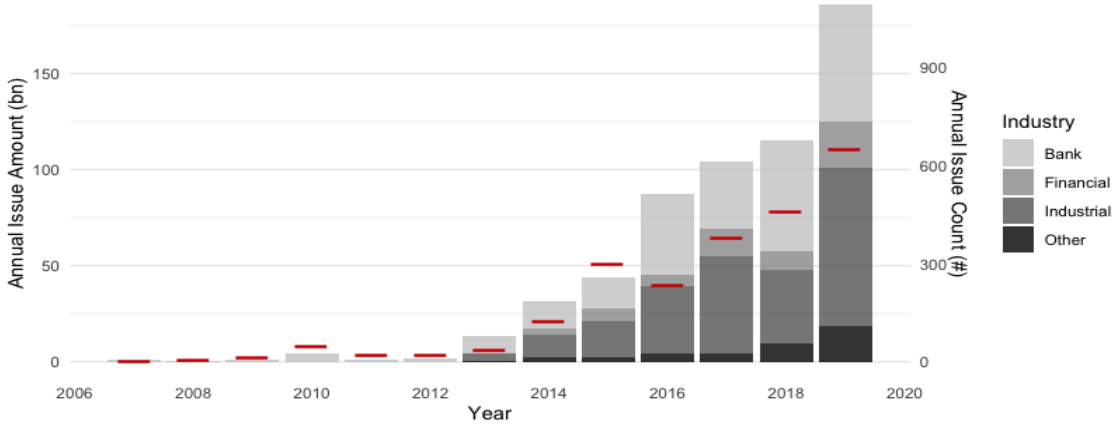
## 6.1 Green Bonds

Figure 1 depicts the total issue amount and count of issuances per year since 2007. The graph is compiled using the Bloomberg fixed income database outputs and includes 2,301 green bonds corresponding to 1,664 unique issuer-days, 1,220 unique issuer-quarters and 591 unique issuers. While largely consisting of corporate bonds the dataset includes some supranational green bonds such as the European Investment Bank's Climate Awareness Bond from 2007. We include such supranational bonds for the descriptive statistics as it paints a clearer picture of the trajectory of the green bond market segment. All non USD amounts are reported in USD for comparison purposes. Our findings are in line with that of Flammer (2021).

Notably, the amount issued and the number of issuances increases substantially in 2013 when the first corporate green bonds were introduced to the markets. We can also clearly see an exponential trend in both metrics pointing at the increasing popularity of the financial instrument. Particularly striking is the jump in amount issued from 2018 to 2019 where total amounts of approximately 115 and 186 billion USD were issued respectively. While not as stark in contrast, this jump is also reflected in the increased count of securities being issued. Since the amount increases proportionally more than the count this indicates that green bond issuers have been showing a tendency to increase the notional amounts of the individual bonds being issued. This observation would be in line with the increased investor demand for such

**Figure 1: Green Bond Issuance**

*The figure displays the issuance of green bonds from 2007-2019 as reported in Bloomberg's fixed income data base. Bonds have been classified by industry with the categories being 1) Banks, 2) Financial firms, 3) Industrial firms and 4) Other. The left-hand side y-axis displays the total annual issuance amount in billion USD. The red bars depict the number of bonds issued in a given year and are read off of the right-hand side y-axis.*




sustainable securities. The increasing slope of both parameters also indicates that this market demand is not yet being saturated and we would assume that the currently observed trajectories in the market will continue.

Focusing on the breakdown by industry, industrial firms make up the largest share of the overall amount issued between 2014 and 2019. This segment of green bond issuers appears to be growing most substantially, driving the overall popularity of the financial instrument. Banks and other financial firms still hold on to a large segment of the market making up approximately 50% of issuances and notional amounts within the sample. Supranational banks as well as private banks were early adopters of the financial instrument contributing substantially to its initial emergence. The trends indicate that firms, that inherently rely on the environment for their daily operations are becoming the dominant drivers in green bond market supply (Flammer, 2021). Most bonds are issued in USD followed by EUR. Since Sweden was fundamental in the creation of the green bond segment the third most issuances are in SEK. Issuances in CNY have been increasing significantly making this another important segment of the overall market environment.

**Table 1: Green Bonds - Descriptive statistics**

*The table displays descriptive statistics for the sample of 2,301 green bonds pulled from Bloomberg's fixed income database with disclosed notional amounts. All bonds have been issued in the period 2007-2019. The ESG score reported is constructed using Bloomberg's proprietary data.*

| Statistic | Maturity (Years) | Amount (USDm) | ESG-Score | Coupon (%) |
|---|---|---|---|---|
| N | 2,273 | 2,301 | 686 | 2,284 |
| Mean | 8.15 | 257.1 | 35.79 | 3.04 |
| Median | 5.08 | 86.9 | 34.70 | 2.65 |

Examining descriptive statistics for the green bond sample (table 1) we find an average notional of 257 USDm, which is in line with Flammer's (2021) findings of approximately 250 USDm. This makes the average green bond issuance rather large in comparison to the overall corporate bond environment. It is, however, important to point out that we find a median issuance volume of only 87 USDm. This is likely due to the fact that Bloomberg reports each tranche of a bond as a individual security, which creates a large tail towards the smaller notionals. At 8.15 years the average maturity of our sample is slightly higher than what Flammer (2021) finds (7.7 years). Green bonds therefore tend to be a form of medium to longer term financing. We also report the average ESG score of our sample firms, however, it is worth pointing out that only a small amount of issuers actually have a ESG score in the Bloomberg database. Finally the average coupon is 3.04% for the green bonds in our sample and for the vast majority of green bonds the coupon is fixed and the bonds are not redeemable prior to maturity i.e. very few green bonds are callable.

## 6.2 Firm Characteristics

To gain a preliminary understanding of the differences between green bond issuers and the general sample of corporate bond issuers we calculate summary statistics on our main variables of interest. Columns 1 and 4 in table 2 report the mean values for our North American conventional bond and green bond issuers respectively. Moving to the right of the mean columns we also compute the median and standard deviations for each firm characteristic and for both samples.

Green bond issuers are likely to be larger firms that are also more profitable and have higher amounts of tangible assets. Larger and more prominent firms will find it easier to gain access to this newly emerging segment of capital markets and can more easily accommodate for the drawbacks. Additionally, this finding seems intuitive as these larger firms might be looking to expand their investor base, which can be achieved through issuance of green bonds. The values for size and profitability exceed the ones reported by Faulkender and Petersen (2006). This is not surprising, as our sample values are more recent and focused exclusively on bond issuers. Intriguingly, we find smaller values for the percentage of tangible assets than Faulkender and Petersen (2006) do. Again this might be due to a structural change over time, wherein firms on average hold less tangible assets than during Faulkender and Petersen's sample period.
For market-to-book we find the inverse relationship between our two samples, wherein green bond issuers on average have lower market-to-book ratios. This again is in line with the previous findings as lower market-to-book ratios indicate that the firm has less substantial growth opportunities and will be more mature in nature. Again the reasoning follows that well established firms with less dramatic growth potential will find it easier to establish a foothold within sustainable financial markets.

Comparing the two metrics for leverage we firstly note that book leverage appears to be consistent across the green bond issuers and the non green bond issuers at approximately 30% - 33%. Moving to market leverage we find some variation particularly between the medians of the two samples. The statistics indicate that within the conventional bond issuer sample we have a lot more firms with lower than average market leverage comparatively. This might also be connected to the observation that the conventional bond issuers tend to be smaller firms that rely less on debt to finance themselves.
Across the metrics SG&A, R&D, return on equity and volatility of assets we find again that the conventional bond issuers display higher mean values than the green bond issuers. As we have already noted higher amount of tangible assets within the green bond sample the finding on both expenditure metrics seems intuitive as we would expect a negative relationship between these variables (Frank and Goyal, 2009). Both higher return on equity and asset volatility might be indicative that the conventional bond sample contains smaller more volatile firms as opposed to the larger and more mature green bond issuers.

**Table 2: Company Characteristics - North America**

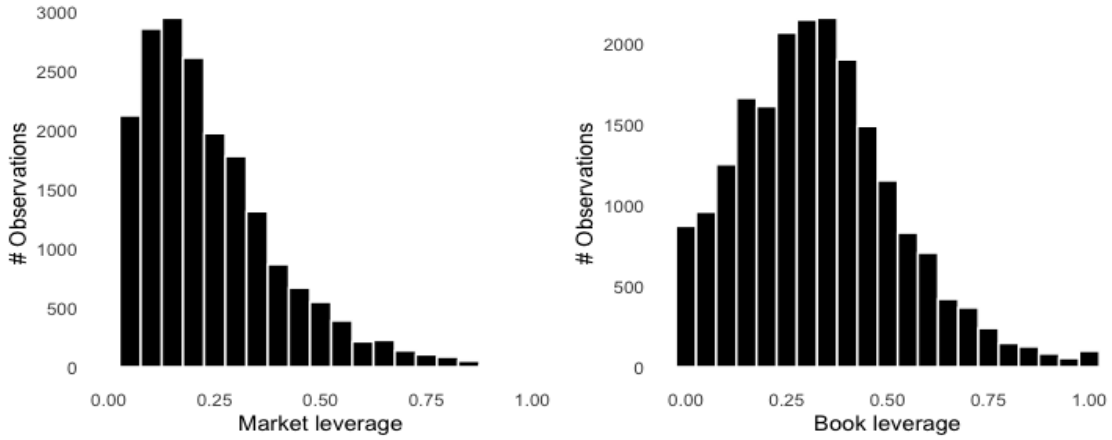
*The table displays descriptive statistics for the 967 firms included in the North American sample. Firm-level data is from Compustat North America and covers the period 2013-2019 reported with a quarterly frequency. Columns 1-3 report mean, median and St. Dev. for convential bonds issuers. Columns 4-6 report for green bond issuers.*

| | Conventional bond issuers | | | Green bond issuers | | |
|---|---|---|---|---|---|---|
| Statistic | Mean | Median | St. Dev. | Mean | Median | St. Dev. |
| Log(Market assets) | 9.06 | 8.96 | 1.66 | 11.07 | 10.92 | 2.47 |
| EBITDA/Sales (%) | 23.2 | 20.1 | 21.9 | 30.5 | 32.8 | 15.1 |
| PPE/Book assets (%) | 27.3 | 15.5 | 27.5 | 37.7 | 33.9 | 30.9 |
| M/B | 1.94 | 1.44 | 1.61 | 1.40 | 1.20 | 0.73 |
| Market leverage (%) | 22.7 | 19.1 | 16.5 | 24.6 | 26.0 | 13.3 |
| Book leverage (%) | 33.0 | 31.5 | 19.7 | 32.8 | 28.2 | 15.6 |
| SG&A/Sales (%) | 21.6 | 16.5 | 21.2 | 15.6 | 9.0 | 17.2 |
| R&D/Sales (%) | 3.7 | 0.0 | 9.1 | 1.6 | 0.0 | 5.0 |
| Stock return (Previous year) (%) | 12.1 | 10.7 | 34.9 | 7.9 | 8.4 | 27.8 |
| $\sigma$ (Assets) (%) | 5.4 | 4.3 | 5.5 | 3.8 | 2.0 | 4.7 |
| Short-term debt/Market assets (%) | 13.3 | 9.5 | 20.3 | 27.2 | 15.2 | 28.4 |
| Long-term debt/Market assets (%) | 86.7 | 95.1 | 20.3 | 72.8 | 84.8 | 28.4 |
| Dividend payer | 0.57 | 1 | 0.50 | 0.76 | 1 | 0.43 |

Within the debt categories we find some very striking differences between the samples. Green bond issuers on average will keep a higher percentage of short-term debt. Green bonds themselves are typically used for long-term financing, therefore, this finding is rather striking. Additionally, we would expect smaller firms to rely more heavily on short-term financing, which appear to be more prevalent in the conventional bond sample. In short this finding is rather interesting, however, not necessarily causally related to the green bond issuances. Finally, we find that across both samples the firms are more likely to pay dividends than not, wherein this probability is even higher among the green bond issuing firms.

**Figure 2: Leverage distributions - North America**

*The graphs display the distribution of leverage ratios (as defined in section 4.2) for the North American sample. Left-hand side x-axis depicts market leverage. Right-hand side x-axis depicts book leverage. Both y-axis show the number of observations*




Comparing the distributions of the two leverage metrics (figure 2) we find that book leverage appears to have a higher mean value at approximately 33% as opposed to 23% for market leverage. Additionally, book leverage appears to follow an approximate normal distribution more closely than market leverage does, which in turn is left skewed. These findings are likely a result of the capital structure adjustment behaviour of our sample firms. Book leverage will have a tendency to be more robust to changes in equity value. Market leverage on the other hand will decrease as market value increases, to which firms will respond with an adjustment in debt only at certain points, causing some inertia (Leary and Roberts, 2005). This inertia could explain the left skew in the observed market leverage data. Comparing our values to previous literature we again find no significant deviations in the behaviour of the data (Faulkender and Petersen, 2006).

Looking at the same descriptive statistics for the international segment of our sample depicted in table 3 we again find that green bond issuers display higher mean values for our proxies for size, profitability and tangibility of assets. Similarly to the North American sample we also find that they appear to have fewer growth opportunities. For book leverage we find very consistent values across sample specifications, whereas for market leverage the mean and

**Table 3: Company Characteristics - International**

*The table displays descriptive statistics for the 1,766 firms included in the International sample. Firm-level data is from Compustat Global and covers the period 2013-2019 reported with a quarterly frequency. Columns 1-3 report mean, median and St. Dev. for convential bonds issuers. Columns 4-6 report for green bond issuers.*

| | Conventional bond issuers | | | Green bond issuers | | |
|---|---|---|---|---|---|---|
| Statistic | Mean | Median | St. Dev. | Mean | Median | St. Dev. |
| Log(Market assets) | 7.23 | 7.38 | 2.42 | 10.00 | 9.68 | 1.80 |
| EBITDA/Sales (%) | 10.9 | 10.6 | 21.3 | 19.6 | 15.8 | 16.0 |
| PPE/Book assets (%) | 25.0 | 19.8 | 21.2 | 37.6 | 34.8 | 20.8 |
| M/B | 1.44 | 1.22 | 0.83 | 1.15 | 1.02 | 0.36 |
| Market leverage (%) | 25.4 | 21.5 | 17.2 | 30.9 | 32.6 | 13.3 |
| Book leverage (%) | 30.3 | 28.2 | 17.0 | 32.8 | 32.8 | 12.7 |
| SG&A/Sales (%) | 22.8 | 17.5 | 24.0 | 13.5 | 13.2 | 10.1 |
| Stock return (Previous year) (%) | 9.9 | 6.5 | 41.7 | 13.3 | 9.3 | 35.3 |
| $\sigma$ (Assets) (%) | 5.9 | 4.7 | 5.9 | 3.7 | 3.0 | 3.3 |
| Short-term debt/Market assets (%) | 30.0 | 23.3 | 24.8 | 22.0 | 18.5 | 16.7 |
| Long-term debt/Market assets (%) | 70.0 | 76.7 | 24.8 | 78.0 | 81.5 | 16.7 |
| Dividend payer | 0.23 | 0.0 | 0.42 | 0.22 | 0.0 | 0.42 |

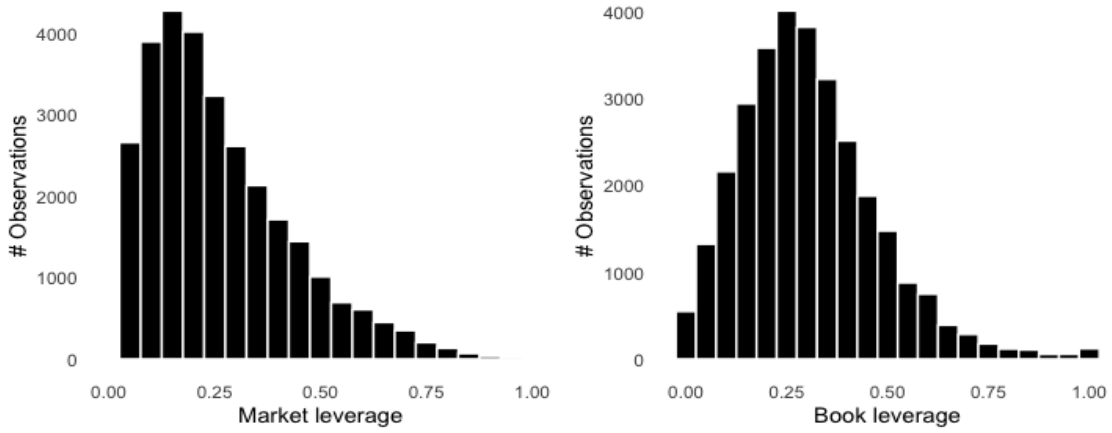
median values are a lot higher for the green bond issuers. While only descriptive this is an indication that we might expect a positive statistical relationship between market leverage and the green bond indicator variable for the subsequent regression analysis.

Since tangibility is higher within our green bond sample we are not surprised to find the inverse relationship for SG&A. For stock return we find that a green bond issuer will on average deliver higher equity returns than a conventional bond issuer. This is in contrast to what we find in the North American sample. Combined with the observation that volatility of assets is higher for the conventional bond sample this finding is rather noteworthy. Intuitive interpretation would suggest that the green bond issuers on average deliver higher equity returns, while also exposing investors to lower volatility. This might be connected to the observation that the sample contains larger firms that face less market risks, but deliver consistent returns.

Unlike in the North American sample, but more in line with theoretical predictions, we find that green bond issuers on average hold more long-term debt. This matches initial expectations as larger, more established firms have a tendency to rely more heavily on long-term financing and green bonds add to this as they have a average maturity of about 8 years within our sample. Finally, concerning the payout of dividends, we do not find any noteworthy difference between the sample of green bond issuers and conventional bond issuers. In both samples the average firm is more likely to not pay dividends.

**Figure 3: Leverage distributions - International**

*The graphs display the distribution of leverage ratios (as defined in section 4.2) for the International sample. Left-hand side x-axis depicts market leverage. Right-hand side x-axis depicts book leverage. Both y-axis show the number of observations*




Comparing the distributions of market and book leverage within the international sample (figure 3), the conclusions are similar to those made on the North American sample. Again we find that book leverage has a higher mean value and that it follows a normal distribution more closely than the market leverage does. Theoretical conjecture would suggest this is due to the impact that changes in equity value have on the metrics, wherein book leverage should remain more robust to any changes. Market leverage is again skewed to the left. A larger amount of firms thus relies on lower leverage ratios, however, the skew is not as stark as with the North American sample.

## 6.3 Specialisation

Our measure of specialisation is, as presented in section 4.2 the Herfindahl-Hirschman Index. Using the same measure Colla et al. (2013) find that for their sample approximately 85% of firms borrow predominantly within one debt type. Since their sample is not restricted to bond issuers and also includes firms without a credit rating, following their own argumentation we expect our sample to have less concentrated debt structures. Rauh and Sufi (2010) examine a sample of only firms with a credit rating[21] and find that a majority of firms (70%) have at least two distinct debt components with bonds and bank debt being the largest.

**Figure 4: HHI distribution - North America**

*The graph displays the distribution of debt specialisation, HHI (section 4.2), for the North American sample. The x-axis depicts the HHI and the y-xais depicts the number of observations.*

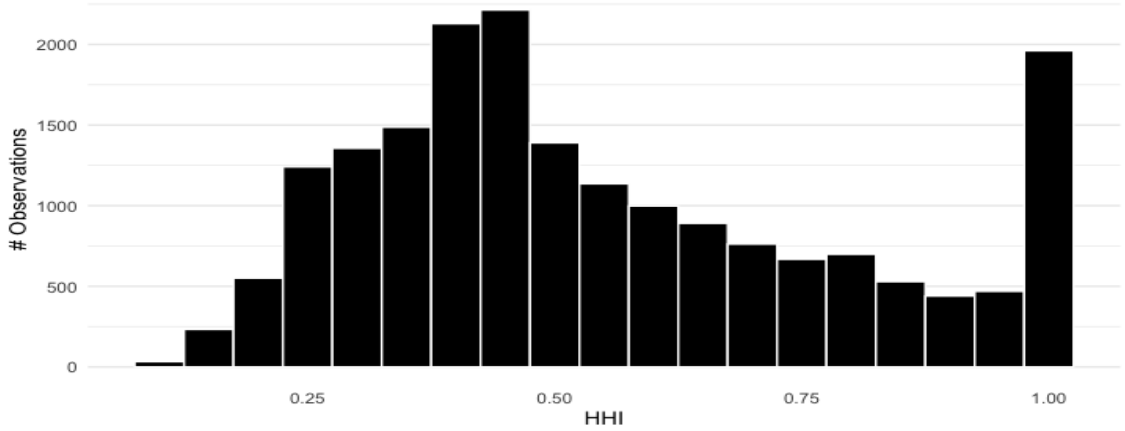



Figure 4 depicts the distribution of the HHI for the North American sample. The distribution suggests that the vast majority of firms rely on more than one type of debt with a mean (median) HHI of 0.55 (0.49). This confirms our expectation that our sample is more diversified than the one examined by Colla et al. (2013) who reports a average HHI of 0.7. Similarly, Halling et al. (2020) finds an average HHI of 0.76 for their sample which similarly to Colla et al. is not restricted to bond issuers, but meant to reflect the entire Compustat universe. Our substantially different average of debt specialisation lends support to the conclusion by Colla et al. (2013) that firms with better access to capital markets (rated firms) will have less specialised debt structures.

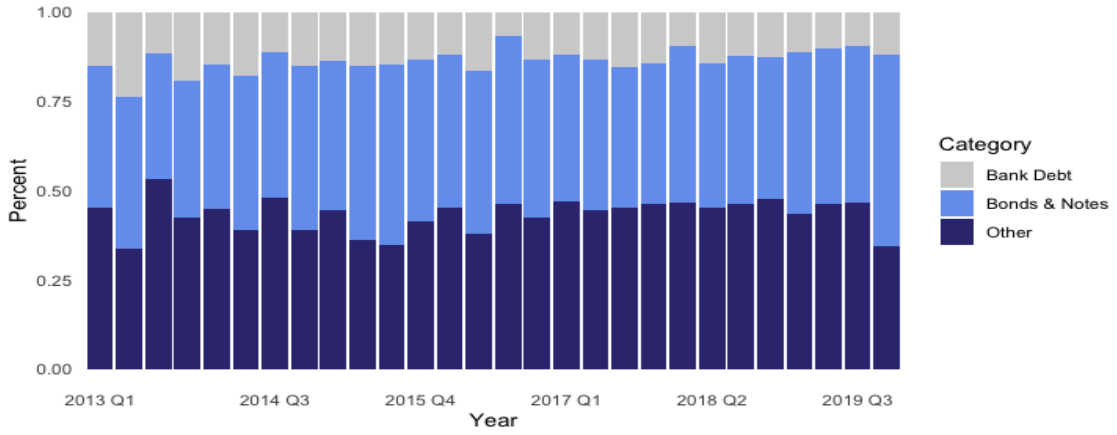
[21] Which is the proxy used by Faulkender and Petersen (2006) for bond market access.

Nevertheless, it is clear from the figure that indeed some firms rely exclusively on one type of debt. Approximately 7.4% of firm-quarter observations[22] have a value of strictly 1 and 14% have a HHI above 90% also indicative of strong debt specialisation. The specialisation of firms appears to conform to traditional predictions as the bottom half of the distribution (0-0.5) are larger, more profitable, more tangible and have fewer growth opportunities on average than the top half (0.5-1). We do not show the evolution of debt specialisation over time, but Colla et al. (2013) report fairly stables HHIs across their eight year sample period.

Examining the underlying components figure 5 shows the high level debt structure for the North American sample. As expected 'Bond & Notes' is the largest debt structure component on average for the sample and it is relatively stable across time with an average value of 43%. This is fairly similar to Rauh and Sufi (2010) who find that their bonds and notes account for approximately 38% of overall debt for the sample of rated firms. Colla et al. (2013) report bonds as two distinct categories, being senior and subordinate, but taken together they account for approximately 48% of firm debt.

**Figure 5: Debt Structure - North America**

*The graph displays structure of debt for the North American sample. Debt is divided into three main categories 1) Bank debt (term loans + revolving credit), 2) Bonds & Notes and 3) All other debt. The x-axis shows the entire sample period starting 2013 Q1 and ending 2019 Q4. The y-axis depicts the fractional split between categories.*




[22]Equivalent to 1428 firm-quarter observations

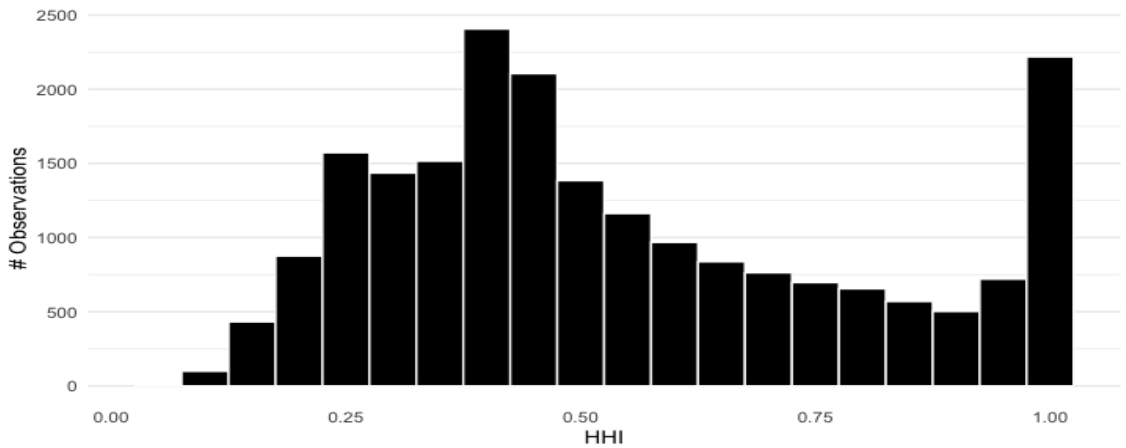
Bank debt is, for the North American sample, not used to the same extend as found in previous studies with an average of 14% and a slight decline over time. Rauh and Sufi (2010) consider bank debt to be both revolving credit and term loans and find that it accounts for around 26% of firm debt structure. For Colla et al. the number is even larger at 43%. This is not all that surprising given that their sample as mentioned also consists of unrated firms which will rely more heavily on bank debt due to the fact that they are unable to borrow in the bond market (Cantillo and Wright, 2000; Faulkender and Petersen, 2006).

While the *Other* part of figure 5 includes several items such as commercial paper, capital leases, trust preferred and other short-term borrowings, the relative consistency and magnitude is another indication of the diversification of debt structure in this sample. At a high level this is in direct contrast to the findings of Rauh and Sufi (2010) who document fairly specialised debt structures among bond issuers. Their sample period is, however, not overlapping with ours and we do not necessarily expect to see the same results as them.

A deeper investigation of the *Other* category unfortunately does not reveal much as the main component is *Other borrowings*[23]. One simple explanation could be related to classification of idiosyncratic debt instruments for firms listed in the United States and Canada, but it is not immediately apparent which instruments would be affected.

**Figure 6: HHI distribution - International**

*The graph displays the distribution of debt specialisation, HHI (section 4.2), for the International sample. The x-axis depicts the HHI and the y-xais depicts the number of observations.*

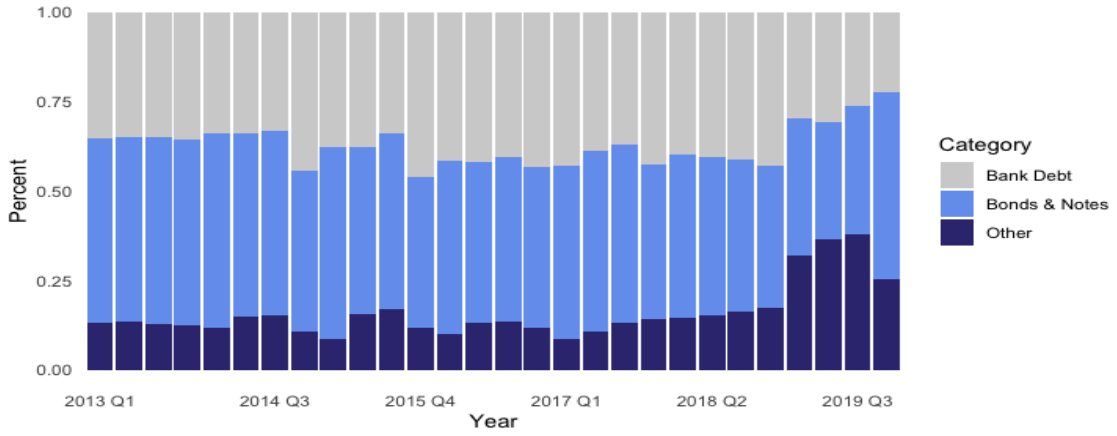



[23] capitalStructureSubTypeId 7 in Compustat - Capital IQ

Shifting focus to the International sample (figure 6), we find a similar distribution of the HHI as with the North American sample. Again at 15% a significant share of firms have a HHI of 0.9 or higher and 7.2% of firm-quarters have a HHI equal to 1. The mean (median) HHI of this part of the sample is 0.54 (0.48), which again is lower than reported by Colla et al. (2013) and Halling et al. (2020). Again we find that the firms on the lower end of the distribution (0-0.5) are larger, more profitable and have more tangible assets, while also having less growth opportunities.

**Figure 7: Debt Structure - International**

*The graph displays structure of debt for the International sample. Debt is divided into three main categories 1) Bank debt (term loans + revolving credit), 2) Bonds & Notes and 3) All other debt. The x-axis shows the entire sample period starting 2013 Q1 and ending 2019 Q4. The y-axis depicts the fractional split between categories.*




In figure 7 we plot the share of the different debt categories over time for the international sample. Firstly, it is worth noting that the share of Bonds & Notes remains rather consistent over time and displays a mean value across time of 47%. This is in line with our findings for the North American sample as well as with the findings of Colla et al. (2013), but substantially higher than what Rauh and Sufi (2010) conclude. Generally, speaking 'Bonds & Notes' is clearly an important financing option for our sample firms, although we can observe this category losing ground to the other categories towards the end of our sample period. Looking at 'Bank Debt' we find an average total debt share of 37%. This is a lot higher than our observations for the North American sample. The firms within our international sample appear to rely a lot more on bank loans and appear to maintain a higher proportion of bank debt in

relation to public debt such as 'Bonds & Notes'. Again we also observe that within the last year of our sample the share of the 'Bank Debt' category appears to be decreasing slightly. Finally, the category *Other* only accounts for an average of 16% of total debt over time, while it was more pronounced for the North American sample. Comparing the international sample with the North American there appears to be a security component captured by the *Other* category, which is a more popular financing tool within North America than outside. Unfortunately, Compustat does not break this category down into further details meaning we cannot identify which type of debt classes are specifically driving this disconnect between the two samples. Nevertheless, this category appears to be gaining significance for the international segment of our sample as its share of total debt is slightly increasing over the sample period.

# 7 Results

The purpose of this section is to outline the main findings from our regression analysis. As discussed in section 4 due to different data availability the main regressions are performed for the two samples independently. Sections 7.1 and 7.2 describe this paper's results with respect to overall leverage of firms. Additional considerations such as industry and maturity are elaborated upon in sections 7.4 and 7.5 respectively. The underlying debt composition is investigated in section 7.6, while 7.7 concludes and discusses the reported results.

## 7.1 Determinants of leverage - North America

Table 4 reports the results for the North American sample. All regressions have market leverage as the dependent variable and different controls are added as one moves to the right. We perform fixed effects estimation for all model specifications. The choice of our estimation method is based on the results from the three main econometric tests as outlined in section 5.3. A full elaboration on the test results and the rationale behind our model choice can be found in the appendix 1. Column 1 is the base regression without the green bond indicator. It serves as a sanity check of the independent variables used extensively in the literature. The four main determinants *profitability*, *size*, *tangibility* and *market-to-book* are discussed in greater detail than other controls.

The expected sign of profitability depends on which of the prevalent capital structure theories one has faith in. According to the static trade-off theory profitable firms will issue more debt as they have higher tax-shield benefits and lower expected cost of default. On the other hand, the pecking order theory suggests there is an inverse relationship as profitable firms will rely more on internal financing (Frank and Goyal, 2009, Shyam-Sunder and Myers, 1999). In the empirical literature profitability has historically been reported with a negative coefficient lending support to the pecking order, but as discussed in section 3.1 this is not necessarily at odds with the trade-off theory (Strebulaev, 2007). Across all five specifications profitability appears with a negative coefficient ranging from -0.02 to -0.06 and is consistently statistically significant. This is very similar to the results reported by Faulkender and Petersen (2006).

Myers and Majluf (1984) show how information asymmetries can increase the cost of borrowing. Firms with more tangible assets on average will therefore have a greater incentive to issue debt (Titman and Wessels, 1988). Frank and Goyal (2009) find tangibility of assets to be one of the most reliable determinants of firm capital structure and in line with theory they find a positive relationship. Rajan and Zingales (1995) similarly find a positive relationship across their international sample. As depicted in table 4 we find a similar positive relationship which is statistically significant. The magnitude is around 0.3 which is larger than found in previous literature[24] (Frank and Goyal, 2009; Faulkender and Petersen, 2006). Since both studies were conducted more than ten years ago and we run our regressions for a different time period it also entirely possible that the underlying leverage dynamics have changed slightly. Titman and Wessel (1988) use the inverse of tangibility i.e. intangible assets as a fraction of total assets and find a magnitude similar to ours (with a negative sign of course).

From a theoretical perspective the effect of size on leverage is again disputed. Generally, the expectation is that large firms face lower probability of default, due to being more diversified as well as having lower agency related costs of debt. The second argument comes from the notion that large firms are typically older and thus would have more established relationships with capital markets. On the other hand, since large firms are typically older they have higher probability of having retained earnings[25] and thus the pecking order would see large firms use less debt (Frank and Goyal, 2009). More established capital market relationships also lower information asymmetries which reduces the cost of issuing equity and as such one should expect the pecking order to be less accurate for large firms. As mentioned in section 3 this is at odds with empirical findings (Frank and Goyal, 2003). With the exception of Germany, Rajan and Zingales (1995) finds a positive relationship between firms size and leverage and positive relationship is generally found in the literature (Titman and Wessels, 1988; Hovakimian et al., 2001; Frank and Goyal, 2009).

[24] Frank and Goyal (2009) finds a coefficient of 0.124 while Faulkender and Petersen (2006) is ranging from 0.12-0.15

[25] The correlation matrices reported in appendix 4 confirm the positive relationship between firm size and profitability for both samples

Faulkender and Petersen (2006) document a negative relationship between firm size and market leverage, which they relate to their decision of restricting their sample to positive debt years only i.e. on the condition that firms have some leverage, large firms are less levered compared to other firms. The result is supported by the negative coefficient documented by Rauh and Sufi (2010). Since their study is restricted to firms with a debt rating they automatically consider levered firms exclusively. Their negative coefficient for overall leverage is, however, not statistically significant. For our North American sample the coefficient is significant and positive across specifications (0.016-0.022). Since our sample is restricted to bond issuers one could expect the coefficient to be negative as it is for Faulkender and Petersen (2006). There are multiple reasons why we don't observe the same relationship. Again, our sample is inherently different from theirs from its construction to the time period considered. Alternatively, if smaller firms have been better at obtaining bond debt over the past fifteen years the effect observed by Faulkender and Petersen (2006) might possibly have been eroded giving us results more in line with other empirical studies.

Debt might make equity aligned managers curb investment even if it is adding to firm value (Myers, 1977) and as such the amount of leverage of a firm becomes dependent on the investment opportunities a firm faces. Furthermore, investment opportunities should increase the cost of financial distress as well as reduce the free cash flow problem, *ceteris paribus*. From the trade-off theory we thus expect a negative relationship between our proxy for growth, *market-to-book*, and firm leverage. If pure pecking order theory is to be considered, we should on the other hand see a positive relationship since firms with more investment opportunities will turn to debt before equity for financing (Frank and Goyal, 2009). In the empirical literature the relationship between growth and leverage has consistently been negative (Rajan and Zingales, 1995; Faulkender and Petersen, 2006; Frank and Goyal, 2009) although Rauh and Sufi (2010) show that while this holds for overall leverage, growth affects components of the debt structure differently.

Across the five specifications in table 4 the coefficient for market-to-book is in line with earlier studies as it is negative and statistically significant. The magnitude is slightly more pronounced than what Faulkender and Petersen (2006) find, however, this might again just be

**Table 4: Determinants of market leverage - North America**

*The dependent variable is the ratio of total debt (long-term + short-term) to the market value of assets (section 4.2.1). We estimate over the period 2013-2019 using a panel regression (equation 3). The green bond variable is equal to 1 for all firm-quarters from and including issuance. All specifications control for firm fixed effects. Additional controls follow the definitions of section 4.3. We report Newey-West standard errors in brackets.*

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| Profitability | −0.033*** | −0.033*** | −0.048*** | −0.056*** | −0.021*** |
| | (0.008) | (0.008) | (0.009) | (0.009) | (0.008) |
| Size | 0.022*** | 0.021*** | 0.020*** | 0.016*** | 0.018*** |
| | (0.003) | (0.003) | (0.003) | (0.004) | (0.003) |
| Tangibility | 0.306*** | 0.305*** | 0.305*** | 0.308*** | 0.261*** |
| | (0.026) | (0.026) | (0.026) | (0.026) | (0.025) |
| M/B | −0.028*** | −0.028*** | −0.028*** | −0.031*** | −0.022*** |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) |
| Green Bond | | 0.017*** | 0.018*** | 0.018*** | 0.015*** |
| | | (0.006) | (0.006) | (0.006) | (0.006) |
| R&D (%) | | | −0.007 | −0.005 | 0.023 |
| | | | (0.017) | (0.018) | (0.015) |
| SG&A (%) | | | −0.057*** | −0.048** | −0.058*** |
| | | | (0.019) | (0.020) | (0.016) |
| Short-term Debt (%) | | | | −0.004 | |
| | | | | (0.006) | |
| Return on Equity | | | | | −0.049*** |
| | | | | | (0.003) |
| Volatility (assets) | | | | | −0.339*** |
| | | | | | (0.030) |
| Observations | 21,058 | 21,058 | 21,058 | 20,548 | 20,057 |
| $R^2$ | 0.127 | 0.127 | 0.129 | 0.140 | 0.223 |
| Controls | Firm | Firm | Firm | Firm | Firm |
| Estimation Method | Within | Within | Within | Within | Within |

*p<0.1; **p<0.05; ***p<0.01

from the difference in samples or time period. Furthermore, they find the magnitude dropping noticeably when accounting for equity returns and asset volatility. While a similar result is present for our specifications the drop is less significant.

### 7.1.1 The Green Bond Effect

As documented in the emerging literature on green bonds the new financial instrument represents an opportunity for some firms to expand their investor base (Flammer, 2021; Tang and Zhang, 2020). Relating this to the argument of debt market frictions presented by Faulkender and Petersen (2006), green bonds are an opportunity for firms who are more financially constrained. By issuing a green bond a new investor base is attracted and the supply of debt financing increases, *ceteris paribus*. The supply argument by Faulkender and Petersen (2006) is proxied by whether or not firms have a debt rating and they find that firms with "access" to the bond market are significantly higher levered. Similarly, we hypothesise that the issuance of a green bond is an indication of expanded capital access and as such firms who have issued a green bond have higher leverage.

Flammer (2021) finds strong support for a signalling argument in her investigation of corporate green bonds (only for certified bonds) meaning that markets seem to derive information about the company on the basis of the green bonds issuance announcements. If the issuance of a green bond lowers the informational asymmetry, this would, from a pecking order theory perspective, lower the cost of debt and ultimately lead to a higher proportion of green bonds in the overall leverage of the firm. On the other hand, as presented in section 2.2, the issuance of a green bond comes with additional requirements related to the use of proceeds and compliance. These added hurdles lend support to the argument that the cost of financial distress is higher for a green bond compared to a conventional bond. If this effect is dominant the trade-off theory would predict lower leverage. Since green bond issuances are becoming more and more prevalent (Flammer, 2021) we view this as an indication of the information effect being a bigger driving force of green bond issuances.

As found by Flammer (2021) green bonds are more information sensitive than conventional bonds, but with a positive impact on equity. What specifically is causing this effect is less clear. It might be that the market views the green investment opportunities as more attrac-

tive. Alternatively, the impact on equity is simply the result of changing investor preferences in which case little information about actual firm value can be derived. Regardless of the underlying dynamics, firms with access to both type of bonds should, all else equal, prefer to issue a green bond. This wold lend support to traditional pecking order, but since the theory is more concerned with hierarchy than actual leverage this has little value for predictions when it comes to the observed market leverage of firms.

Finally, since Flammer (2021) finds the positive effect on equity the firms market capitalisation will increase as a result of a green bond issuance. Since our dependent variable is market leverage a green bond issuance should therefore lead to an increase of both the numerator and the denominator. Which effect dominates depends on the notional of the bond and the abnormal return to equity. Using the CAR found by Flammer (2021)[26] the median[27] firm adds 20 USDm to its market capitalisation. The average notional on a green bond is approximately 250 USDm which is substantially higher than the gain on equity. All things taken together one should expect green bond issuances to have a positive impact on the market leverage of firms.

As predicted the coefficient for the green bond indicator shown in table 4 for columns 2-5 is positive and statistically significant for all specifications. The magnitude is fairly consistent ranging from 1.5-1.8 percentage points. Particularly interesting is the robustness of the green bond coefficient to the inclusion of return on equity in column five[28]. As expected the return on equity as well as the volatility of a firm's assets will reduce market leverage. This is consistent with other empirical findings (Faulkender and Petersen, 2006; Frank and Goyal, 2009). The magnitude of the coefficient is not insignificant either. Using the full specification, controlling for other firm characteristics, a green bond issuer (green bond indicator = 1) will have a 1.5 percentage point higher market leverage ratio. The marginal effect at the mean (median) equals a 7% (7.8%) increase in the market leverage ratio. Following the argumen-

[26]The CAR is 0.49%, but is only significant for certified bonds

[27]We are using the median firms since the North American average is heavily influenced by companies such as Walmart and Apple

[28]As the equity effects is found upon announcement rather than issuance (Flammer, 2021), we should observe an equity effect in our coefficient if present

tation of market access by Faulkender and Petersen we compare our findings to their proxy for market access. Their results show greater variability depending on controls, but range between 5-8 percentage point. This is greater than our finding of 1.5 percentage point, but it is unsurprising given that the gap from no access to bond financing is greater than the gap between conventional bonds and green bonds. Nevertheless, these results are an indication of firms perhaps being too conservatively levered despite access to conventional bond capital markets.

We compare our findings to the conclusions made by Flammer (2021), wherein she finds no significance difference in book leverage between the green bond issuers and conventional bond issuers in her sample. The first and main difference to point out is that the estimations reported in table 4, compare market leverages rather than book leverages across firms. We rerun our leverage regressions using book leverage and again find a significant difference in leverage ratios between green bond issuers and conventional bond issuers. Within this specification it is striking that the statistical significance of our green bond indicator diminishes. This means that our results are not as stark as they are for the market leverage regressions and making them more comparable to the results by Flammer (2021).

Additionally, our analysis differs from that of Flammer (2021) by the methodology we employ. Flammer (2021) compares the mean values of her sample firms after having condensed her sample through the matching approach. The matched representative sample of conventional bond issuers thus contains those firms that most resemble the green bond issuers within her sample. In our case, we perform a regression analysis, which allows us to control for firm specific characteristics in order to single out the relationship between our green bond indicator and the leverage ratio (market or book) for our North American sample. Therefore, our findings do not necessarily contradict those of Flammer (2021) and instead act as an additional investigation into her conclusion. As outlined in section 6 the mean values of book leverage within our North American sample are 33% for our conventional bond issuers and 32.8% for our green bond issuers. We compare these values to the findings of Flammer (2021) which are 35% and 33% respectively for her total sample. From these mean values we can see that our sample leverage values do not differ in a noteworthy way and it is the

nature of the regression analysis, which allows us to control for firm specific characteristics, that informs our hypothesis that green bond issuers on average maintain higher leverage ratios.

While profitability, size, tangibility and growth serve as the main controls for our finding, additional controls are added for columns 3-5 of table 4 and some warrant comments. Titman and Wessel (1988) view both R&D and SG&A expenditures as proxies for uniqueness and through that the collateral value of a firms assets. Similarly, Frank and Goyal (2009) state that firms with high expenditures in both categories have more intangible assets and therefore should have less debt. From a trade-off theory perspective both variables are therefore expected to have a negative coefficient. For our specifications only SG&A is statistically significant in all three and with the predicted sign. R&D, while statistically insignificant, is negative in columns 3-4 and actually changes sign for the $5^{th}$ specification. The lacking significance of R&D is not all that surprising given a large fraction of our sample firms did not report any such expenditure.

Following Faulkender and Petersen (2006)[29] we include a firm's short-term debt as a percentage of total debt. We would expect a negative coefficient as Myers (1977) suggests short-term debt can potentially fix the debt overhang problem. While the coefficient is negative it is not statistically significant and we therefore do not include it in column 5. Finally, as mentioned both equity return and asset volatility are significant and have negative coefficients as predicted. The theoretical justification for including asset volatility is that more volatile firms are expected to have higher probability of financial distress and for this reason should have lower leverage according to the trade-off theory (Faulkender and Petersen, 2006). We include equity return to account for the potential inertia of firms (Welch, 2004). If firms are not abiding by a strict trade-off theory[30] stock returns will explain much of the variation in firms' leverage ratio (market leverage). The negative coefficient of stock return is bigger in magnitude than previous work (Faulkender and Petersen, 2006), but does not affect the other controls and does not change the impact of the green bond indicator.

[29] They do, however, not include short-term debt in their panel estimation

[30] Which they don't as documented in the literature and discussed in section 3.1

## 7.2 Leverage Results - International Sample

Table 5 reports the market leverage regression results from the international sample. It is important to note that the data for the international sample, while larger in terms of observations than the North American sample, contains more missing data points. Additionally, Compustat Global does not report the exact same identifiers and variables as the North American repository does, making replication of leverage regressions in the empirical corporate finance literature more difficult and prone to deviations. Most notably we were unable to obtain a measure for R&D expenditure for this part of the sample as Compustat does not report this metric for its Global Quarterly dataset. Therefore, R&D is omitted as a control variable from the international sample regressions. Since the coefficient of R&D does not appear particularly relevant within the specifications in table 4, we hypothesise that including this measure would not significantly change the estimations for the international sample either and proceed to perform robustness checks on our coefficients using only the other independent variables available to us. Nevertheless, the results for the international part of the sample largely coincide with the estimates for the North American subset with few but noteworthy deviations.

The independent variable in table 5 is again the market leverage. All specifications include the main independent variables profitability, size, tangibility and market-to-book as well as our green bond indicator. The table follows the same structure as table 4. As we move from column 1 to 5 we have included additional control variables expanding our model specification. All outputs follow from fixed effects estimations. As with the North American sample the choice of estimation method is based on the econometric tests performed on the data. Full details on the test outcomes and model choice rationale can be found in appendix 1.

Most interesting within our findings for the international sample is the coefficient on the green bond indicator variable. The coefficient on the indicator variable remains insignificant throughout the different models estimated. From this we conclude that we do not have evidence consistent with our findings for the North American sample.
As the green bond indicator coefficient is insignificant, we acknowledge that we cannot make any inferences on the basis of it or make any conclusions about green bond market access and

**Table 5: Determinants of market leverage - International sample**

*The dependent variable is the ratio of total debt (long-term + short-term) to the market value of assets (section 4.2.1). We estimate over the period 2013-2019 using a panel regression (equation 3). The green bond variable is equal to 1 for all firm-quarters from and including issuance. All specifications control for firm fixed effects. Additional controls follow the definitions of section 4.3. We report Newey-West standard errors in brackets.*

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| Profitability | −0.014** | −0.014** | −0.013** | −0.013** | −0.006 |
| | (0.007) | (0.007) | (0.006) | (0.006) | (0.006) |
| Size | 0.024*** | 0.025*** | 0.025*** | 0.024*** | 0.027*** |
| | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) |
| Tangibility | 0.324*** | 0.324*** | 0.324*** | 0.323*** | 0.302*** |
| | (0.028) | (0.028) | (0.028) | (0.029) | (0.028) |
| M/B | −0.067*** | −0.067*** | −0.067*** | −0.067*** | −0.061*** |
| | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) |
| Green Bond | | −0.008 | −0.008 | −0.008 | −0.013 |
| | | (0.014) | (0.014) | (0.014) | (0.014) |
| SG&A (%) | | | 0.003 | 0.003 | 0.002 |
| | | | (0.005) | (0.005) | (0.004) |
| Short-Term Debt (%) | | | | −0.003 | |
| | | | | (0.006) | |
| Return on Equity | | | | | −0.026*** |
| | | | | | (0.002) |
| Volatility (assets) | | | | | −0.217*** |
| | | | | | (0.024) |
| Observations | 30,489 | 30,489 | 30,489 | 30,487 | 30,489 |
| $R^2$ | 0.184 | 0.184 | 0.184 | 0.184 | 0.229 |
| Controls | Firm | Firm | Firm | Firm | Firm |
| Estimation Method | Within | Within | Within | Within | Within |

*p<0.1; **p<0.05; ***p<0.01

its interaction with market leverage within our international sample. Nevertheless, it is striking that the sign of the coefficient is negative. This finding warrants some discussion so as to assess whether a negative correlation is theoretically feasible. Intuitively, we suspect the neg-

ative correlation with leverage is driven by the CAR of a firm's equity return as identified by Flammer (2021) . Green bond issuances tend to drive abnormal equity returns, which in turn would raise market capitalisation. This increase in market value increases the denominator of the market leverage variable making a negative sign on the green bond indicator theoretically feasible if this increase in market capitalisation outweighs the effect the additional debt would have on the leverage ratio.

Shifting focus to our control variables we start by examining the coefficient on the profitability variable. As indicated by the empirical literature and as found in the North America regressions the coefficient on profitability is negative and rather small in terms of magnitude. The coefficient remains statistically significant, except for the full model specification in column 5. The coefficient on size is largely in line with the regressions of the North American sample, while also being significant at the 1% level across all columns. The positive sign is in line with previous literature as larger firms also tend to have higher leverage within our sample.
The coefficients on tangibility of assets are very consistent across all model estimations remaining positive in sign and significant at the 1% level throughout. This also matches the theoretical expectation for the sign on tangible assets. The magnitude of the coefficient decreases slightly when including the additional control variables return on equity and volatility of assets.
The market-to-book ratio shows the largest change when compared to the results in our North American regressions. The sign and statistical significance of the coefficient is in accordance with expectations. The magnitude of the coefficient is almost double that of the coefficients for the North American sample (in absolute terms). Theoretically, as the market-to-book ratio acts as a proxy for growth opportunities within a firm we would expect a negative relationship between it and the leverage of a firm.

A key consideration when analysing the results for our international sample is that Compustat does not report very granular data on a quarterly frequency as is evident by the absence of the R&D variable. This also causes some rather important bond issuers to be excluded from the data sample as there is simply no data available for them. Considering these caveats and the fact that we lose a number of bond issuing firm observations due to our data availability

limits, we are not particularly surprised to find insignificant coefficients on the green bond indicator. Therefore, as a robustness check of our findings we also perform a first difference estimation on our dataset. The outputs are reported in the appendix 2. In performing the first difference estimation as an additional verification of our findings we are following the example of Faulkender and Petersen (2006). For the first difference estimations we find no noteworthy differences in the control coefficients of the independent control variables. The starkest difference lies in the coefficient of the green bond indicator variable. Specifically, the coefficient becomes positive and statistically significant and generally is more in line with the findings of our North American sample. This result is rather striking. From econometric theory we conclude that both estimation methods are unbiased and consistent, given that the OLS assumptions hold. Thus, the difference in coefficient is likely attributable to some underlying endogeneity in this part of the sample. Nevertheless, since the fixed effects estimation shows a non significant green bond indicator coefficient and since the first difference estimations return a green bond indicator in line with our findings for the North American sample we conclude that the findings for our international sample, while not corroborating the previous findings, also do not substantially contradict them.

### 7.3 Comments on Book Leverage

Following Faulkender and Petersen (2006) we only report regression results with market leverage as the dependent variable. Given that book leverage has frequently been reported in the academic literature (Rajan and Zingales, 1995; Frank and Goyal, 2009; Rauh and Sufi, 2010) we briefly comment on noticeable differences between book and market leverage regressions while the total output table can be found in appendix 3.

For the North American sample the book leverage results are fairly consistent with those reported in table 4. With the exception of the full specification the green bond indicator remains relevant[31]. Here the coefficient loses its statistical significance. One possible explanation is the severe impact from asset volatility which is large in magnitude and very statistically significant. Unsurprisingly, equity returns have a smaller impact on book leverage. The effect in truth only materialises if the company issues additional equity which is then recorded on the

[31] Although it is only significant at the 10%-level

balance sheet at a higher stock price. If the stock effect from green bonds found by Flammer (2021) is significant across firms and time, the smaller effect on book leverage is somewhat surprising as this counteracting effect on the leverage ratio should be more pronounced for market leverage than book leverage. Despite this the book leverage results for North America are not contradicting our main findings. The main leverage determinants have coefficients with the expected sign although market-to-book and tangible assets are slightly less pronounced while size becomes more dominant.

For the international sample, examining the book leverage regressions, we find that the green bond indicator is insignificant across all model specifications. This finding is similar to the results of the market leverage regression. In terms of magnitude the green bond indicator is now positive, with the exception of the model in column 5. The coefficient on size becomes more pronounced, while tangible assets also increases in terms of magnitude. Key changes occur for the coefficients on profitability and market-to-book. Starting with profitability it is noteworthy that the coefficient becomes larger in terms of absolute magnitude and remains statistically significant at least at the 10% level throughout. Market-to-book, while also remaining significant, decreases substantially in terms of absolute magnitude from approximately 0.067 in the market leverage regression to 0.019 in the book leverage regressions. This coefficient magnitude is more in line with our findings for the North American sample. In general the book leverage regressions act as a sanity check on the underlying statistical relationships and do not contradict our previous findings or the previous literature.

## 7.4 Industry Considerations

By splitting our sample between North America and the rest of the world we attempt to account for firms being different across locations. As documented by Rajan and Zingales (1995) the explanatory factors for firm leverage do seem to vary across countries, however, not as substantially as expected. More importantly, the differences can not be explained by institutional differences. The results from section 7.1 and 7.2 show some geographical variation in our results.

Additionally, we want to consider differences across industries as robustness check for our findings. As industry can be thought of as a proxy for business risk, firms within the same industry tend to have the same business cycle which might impact their leverage decision. Remmer et al. (1974) do, for a sample of international manufacturing firms, not find the significant effect of industry classification, but conclude that other factors such as earnings rate and growth are more important determinants of firm leverage. McKay and Phillips (2005), on the other hand, find that industry classification matters for firm leverage and additionally the position of the firm within the industry also matters for firm capital structure. Their results show that leverage tends to be higher and less dispersed for industries with a higher concentration of firms. Leverage becomes a strategic component for firms in the same industry where a significant deviation from the industry median is directly related to the technology and risk choice at the firm level.

Accounting for industry fixed effects has thus become common practice in the empirical literature. Korteweg (2010) groups firms either by the two-digit SIC our uses the Fama-French industry classification. Colla et al. (2013) also accounts for industry fixed effects by including the Fama-French 48 industry groupings (Fama and French, 1997). DeAngelo and Roll (2015) find large variation in within-industry median leverage. Using the 4-digit SIC they report large within-industry time series variation comparable in significance to the cross-industry difference in leverage they find for specific points in time. Faulkender and Petersen (2006) run their investigation using both firm and industry fixed effects. They include dummies for each four-digit SIC industry, but their conclusion with respect to their access proxy is unchanged from the firm fixed effect specification[32]. We follow similar methodology and the results are reported in table 6.

Within the empirical corporate finance literature banks and financial firms are treated with particular caution. As noted by Fama (1985) banks are inherently different from other types of firms. Empirically it is also not disputed that banks tend to have leverage ratios which are substantially higher than those found for non-financial firms (Gornall and Strebulaev, 2018). As banks exhibit different capital structure behavior than other firms and are subject to differ-

[32]Referenced results can be found in Faulkender and Petersen (2006) table. 5 columns I and III

**Table 6: Industry Specifications**

*The dependent variable is the ratio of total debt (long-term + short-term) to the market value of assets (section 4.2.1). We estimate over the period 2013-2019 using a panel regression (equation 3). The green bond variable is equal to 1 for all firm-quarters from and including issuance. Additional controls follow the definitions of section 4.3. Results for the North American and International sample are reported in columns 1-2 and 3-4 respectively. Columns 1 and 3 excludes financial firms from the sample (regressions are firm fixed effects). Columns 2 and 4 include industry fixed effects through 4-digit SIC dummies (unreported). We report Newey-West standard errors in brackets for firm fixed effects and White standard errors for industry fixed effects.*

| | *North America sample* | | *Global sample* | |
|---|---|---|---|---|
| | Excl. Financials | Industry FE | Excl. Financials | Industry FE |
| | (1) | (2) | (3) | (4) |
| Profitability | $-0.045^{***}$ | $0.023^{***}$ | $-0.014^{***}$ | $0.012^{**}$ |
| | (0.008) | (0.007) | (0.005) | (0.005) |
| Size | $0.023^{***}$ | $-0.001$ | $0.025^{***}$ | $-0.007^{***}$ |
| | (0.003) | (0.001) | (0.004) | (0.0005) |
| Tangible | $0.300^{***}$ | $0.064^{***}$ | $0.323^{***}$ | $0.201^{***}$ |
| | (0.026) | (0.010) | (0.017) | (0.006) |
| M/B | $-0.029^{***}$ | $-0.030^{***}$ | $-0.067^{***}$ | $-0.071^{***}$ |
| | (0.002) | (0.001) | (0.006) | (0.003) |
| Green Bond | $0.023^{***}$ | $0.023^{***}$ | $-0.008$ | $-0.001$ |
| | (0.006) | (0.006) | (0.009) | (0.007) |
| Observations | 16,997 | 21,058 | 30,458 | 30,450 |
| $R^2$ | 0.138 | 0.548 | 0.184 | 0.454 |
| Controls | Firm | Industry | Firm | Industry |
| Estimation method | Within | Within | Within | Within |

$^{*}$p<0.1; $^{**}$p<0.05; $^{***}$p<0.01

ent rules and regulations it has become common practice to exclude them and other financial firms from empirical investigations (Rajan and Zingales, 1995; Faulkender and Petersen, 2006; Frank and Goyal, 2009; Colla et al., 2013). As a fraction of our green bond issuers are financial firms we rerun our main specification (column 2 from table 4) with financial firms excluded[33].

[33]We exclude firms with an SIC between 6000-6999

### 7.4.1 Robustness of Results

Table 6 reports the different specifications in which we account for industry effects. Columns 1-2 show the findings for the North American sample, while columns 3-4 show findings for the international sample. The first specification which excludes financial firms is very similar to column 2 from table 4. The main leverage determinants are all of same sign and similar magnitude and the statistical significance is unchanged. The green bond indicator remains significant as well and is slightly bigger in magnitude at 2.3 percentage points. The results indicate that the impact of green bonds on firm leverage found for the North American sample is not driven by a subset of financial firms who issue green bonds and have higher leverage relative to the rest of the sample. Flammer (2021) also finds that her results on corporate green bonds are robust to the exclusion of financial firms although her findings are not related to leverage, but equity returns.

In the $2^{nd}$ specification industry dummies are included. In total 202 four-digit SIC dummies are included, but the green bond indicator remains significant and of similar magnitude. Interestingly, the coefficient for profitability changes sign in industry fixed effect regression, while size becomes insignificant (and negative). When accounting for differences across industries, profitable firms appear to have higher leverage ratios. This observation is at odds with Faulkender and Petersen (2006) who do not see any material difference in their coefficients for the firm and industry specifications. The $R^2$ is substantially higher for the dummy regression. This is a natural consequence of including a high number of additional controls (dummies) and as such the statistic becomes nonsensical[34]. Overall the industry considerations do not change the conclusion for the North American sample.

Examining the output in columns 3 and 4 provides several noteworthy insights. First of all, excluding financial firms and running a firm fixed effects regressions does not change the conclusion of table 5 (exactly as for North America). We estimate an industry fixed effects regression for the internationl sample in column four. As in column 2 we perform a industry dummy regression, which allows us to control for industry specific effects and we report the results with standard errors corrected for heteroskedasticity. In accordance with the results

[34]Faulkender and Petersen (2006) also address this in their paper

for the North American sample, profitability now appears with a positive coefficient and size becomes negative (and significant) for the industry dummy regression. As for table 5 the green bond indicator remains insignificant and slightly negative for both columns 3 and 4. Similar to the North American results, the exclusion of financial firms does not change our conclusion with respect to the green bond indicator as we again find insignificant coefficients for our international sample. These results appear to be robust to the exclusion of financial firms for the international sample as well. This is not a big surprise since very few financial firms are included in the international sample in the first place. This is not by design, but a result of the data quality provided by Compustat Global for these firms.

## 7.5 Impact on Debt Maturity

As introduced in section 3.1 firms might alleviate certain agency costs of debt by adjusting the maturity profile of their debt obligations. Specifically, firms with more growth opportunities should rely more heavily on short-term debt to avoid the cost of *debt overhang* (Myers, 1977). As shown by Diamond and He (2014) under-investment might still be present, or even more severe, for shorter maturities. This is especially true for firms with very volatile assets (particularly in recessions) as short-term debt induces earlier liquidation of the firm. Short-term debt can also be viewed as a commitment of the firm to keep leverage relatively low as debt is automatically reduced through maturity if it is not rolled over. Admati et al., however, (2018) document that equity owners will have a continued incentive to increase firm leverage despite the shorter maturities. This is done by increasing leverage more aggressively prior to the debt maturing[35].

Our sample's descriptive statistics presented in section 6.2 reveal that for the international sample conventional bond issuer who on average have more growth opportunities (as proxied by M/B) rely more heavily on short-term debt compared to the green bond sample. This is in accordance with Myers (1977). An inverse relationship is found for the North American sample. Neither table 2 nor 3 can directly reveal whether there is an association between

[35]The paper's main contribution is the notion a *leverage ratchet effect* which shows that equity owners will have an incentive to increase firm leverage as long as the debt tax shield is not fully exploited. This prediction is not supported empirically.

firms reliance on long-term debt and the issuance of green bonds. This section examines the potential relationship in more detail.

Since short-term debt is refinanced more frequently it conveys more information to the market than long-term debt does (Diamond, 1991). On one hand, for a firm with good and stable performance this signalling effect might be attractive, on the other, a heavy reliance on short-term debt increases the probability of a negative shock to a firm's operation forcing it into

**Table 7: Maturity structure effects - North America**

*In columns 1-2 the dependent variable is the ratio short-term and long-term debt to the market value of assets (section 4.2.2). In columns 3-4 the denominator is total debt (short-term + long-term). We estimate over the period 2013-2019 using a panel regression (equation 3). The green bond variable is equal to 1 for all firm-quarters from and including issuance. All specifications control for firm fixed effects. Additional controls follow the definitions of section 4.3. We report Newey-West standard errors in brackets.*

| | *Scaled by market assets* | | *Scaled by total debt* | |
|---|---|---|---|---|
| | Short-term | Long-term | Short-term | Long-term |
| | (1) | (2) | (3) | (4) |
| Profitability | $-0.014^{**}$ | $-0.019^{***}$ | $-0.032^{***}$ | $0.032^{***}$ |
| | (0.006) | (0.007) | (0.012) | (0.012) |
| Size | $-0.001$ | $0.023^{***}$ | $-0.042^{***}$ | $0.042^{***}$ |
| | (0.001) | (0.003) | (0.005) | (0.005) |
| Tangibility | $0.035^{***}$ | $0.271^{***}$ | 0.027 | $-0.027$ |
| | (0.011) | (0.025) | (0.023) | (0.023) |
| M/B | $-0.002^{***}$ | $-0.026^{***}$ | $0.018^{***}$ | $-0.018^{***}$ |
| | (0.001) | (0.002) | (0.003) | (0.003) |
| Green Bond | 0.003 | $0.014^{**}$ | $-0.024^{*}$ | $0.024^{*}$ |
| | (0.003) | (0.006) | (0.014) | (0.014) |
| Observations | 21,058 | 21,058 | 20,548 | 20,548 |
| $R^2$ | 0.008 | 0.115 | 0.017 | 0.017 |
| Controls | Firm | Firm | Firm | Firm |
| Estimation method | Within | Within | Within | Within |

$^{*}$p<0.1; $^{**}$p<0.05; $^{***}$p<0.01

liquidation (or at least financial distress). The second effect suggests that firms with more severe managerial frictions should rely more heavily on short-term debt as it disciplines the manager more effectively (Diamond, 1991). Barclay and Smith (Barclay and Smith Jr, 1995) find little evidence that debt maturity is used as a signalling mechanism, but confirm the prediction of Myers (1977).

In table 7 we estimate four regressions for the North American sample in which the dependent variable no longer is overall market leverage. Columns 1 and 2 show our base leverage regression, with short and long-term debt as a fraction of total market assets as the dependent variable respectively. Additionally, columns 3 and 4 show the same component of firm debt (short and long-term), but scaled by total debt. Essentially, the first two regressions examine in which manner short and long-term debt interact with the overall capital structure, while the the third and fourth estimate the relationship within the debt structure of the firm.

In columns 1 and 2 we observe that our proxy for green debt market access is only significant for long-term debt. The positive coefficient speaks to the longer maturity of green bonds and indicates that green bonds primarily enter as a long-term component of the overall capital structure. The traditional independent variables, with the exception of size, have the same sign for short and long-term debt. Profitability and market-to-book are negative indicating that firms with more growth opportunities use less of both types of debt while firms with more tangible assets have higher leverage across the two sub-components.

Examining columns 3 and 4, the green bond indicator is negative for short-term debt and positive for long-term debt (and statistically significant). This is also consistent with the argumentation of Faulkender and Petersen (2006) who argue that more constrained firms will tend to rely more heavily on short-term financing (primarily from banks). More specifically, we observe that controlling for firm characteristics, the presence of a green bonds adds 1.4 percentage point to the long-term market leverage of the firm. If the green bond effect on long-term leverage reflects the full notional of a green bond we should observe approximately a 3 percentage point increase[36]. The fact that we find a less pronounced effect is suggestive of

[36] Average notional of a green bond is around 250 USDm (see section 6.1)

some substitution taking place within the long-term debt of the firm. Within the overall debt structure the results in columns 3 and 4 show that firm characteristics and green debt access influence the maturity structure of firms. The coefficients are the exact opposite signs for all explanatory variables since the dependent variables are the inverse of each other.

Furthermore, we find that market-to-book is negative for long-term debt, in line with the findings of Barclay and Smith (Barclay and Smith Jr, 1995). The results suggest that larger and more profitable firms rely more on long-term debt financing. Faulkender and Petersen (2006) also find that larger firms use more long-term debt. While we do not find other studies that examine maturity in relation to the tangibility of assets, following the argument of Diamond (1991) we would expect a positive relationship. Firms with more tangible assets have less information asymmetries and thus benefit less from frequent refinancing of short-term debt. In turn they establish long lasting relationships with debt capital markets to obtain more favourable terms.
One caveat to the results presented in table 7 is the simplicity of the maturity definition. Choi et al. (Choi et al., 2018) examine this aspect of debt structure at a more granular level and show that firms with more growth opportunities tend to have more dispersion in the maturity profile of corporate debt.

In table 8 we report the regression results for the international leverage regressions distinguishing between long-term and short-term debt[37]. Particularly the coefficient on the green bond indicator, while not significant for the overall leverage ratio seems to have an impact on the maturity structure of firm debt.

The coefficients on the green bond indicator have the expected signs across both models and remain consistently statistically significant across specifications, with the exception being the long-term leverage regression in column 2. Interestingly, for the market assets scaled leverage ratios (columns 1-2) the green bond indicator is associated with lower short-term debt ratios but we do not find a significant coefficient for the long-term leverage. The statistical

[37]As with market leverage we run first-difference estimations for the international sample. Results are reported in appendix 5

**Table 8: Maturity structure effects - International sample**

*In columns 1-2 the dependent variable is the ratio short-term and long-term debt to the market value of assets (section 4.2). In columns 3-4 the denominator is total debt (short-term + long-term). We estimate over the period 2013-2019 using a panel regression (equation 3). The green bond variable is equal to 1 for all firm-quarters from and including issuance. All specifications control for firm fixed effects. Additional controls follow the definitions of section 4.3. We report Newey-West standard errors in brackets.*

| | *Scaled by market assets* | | *Scaled by total debt* | |
|---|---|---|---|---|
| | Short-term | Long-term | Short-term | Long-term |
| | (1) | (2) | (3) | (4) |
| Profitability | $-0.026^{***}$ | $0.012^{*}$ | $-0.040^{**}$ | $0.040^{**}$ |
| | (0.006) | (0.007) | (0.017) | (0.017) |
| Size | $-0.003$ | $0.027^{***}$ | $-0.066^{***}$ | $0.066^{***}$ |
| | (0.003) | (0.005) | (0.010) | (0.010) |
| Tangibility | $0.054^{***}$ | $0.270^{***}$ | $-0.134^{***}$ | $0.134^{***}$ |
| | (0.019) | (0.028) | (0.047) | (0.047) |
| M/B | $-0.017^{***}$ | $-0.050^{***}$ | $0.015^{**}$ | $-0.015^{**}$ |
| | (0.002) | (0.007) | (0.007) | (0.007) |
| Green Bond | $-0.011^{***}$ | 0.003 | $-0.054^{***}$ | $0.054^{***}$ |
| | (0.004) | (0.012) | (0.018) | (0.018) |
| Observations | 30,489 | 30,489 | 30,487 | 30,487 |
| $R^2$ | 0.019 | 0.105 | 0.016 | 0.016 |
| Controls | Firm | Firm | Firm | Firm |
| Estimation method | Within | Within | Within | Within |

$^{*}$p<0.1; $^{**}$p<0.05; $^{***}$p<0.01

significance in the short-term leverage regression hints at a substitution effect. As firms with access to the green bond market issue less short-term debt it would appear that they are substituting the short-term debt for other longer term debt categories. We cannot conclusively say whether the displacement of short-term debt is based on the issuance of green bonds specifically; it could instead follow from an unobserved firm characteristic unique to the green bond issuing firms. The prevalence of the significant negative coefficient, however, warrants further investigation.

The traditional leverage determining variables are significant at the 10% level with exception of size. It is insignificant for the short-term debt regression in column 1. Profitability changes sign between the long term and short term regressions. Tangibility appears to have a positive correlation with both debt components, whereas market-to-book appears to have a negative relationship. This is in line with expectations as the general leverage regressions from table 5 unambiguously show the same statistical relationships for these two variables.

Looking at columns 3 and 4 it is noteworthy that we find statistical significance at least at the 10% level for all parameters presented in the columns. As with the North American sample, we find that being a green bond issuer affects the long-term leverage positively, while relating to short-term leverage negatively. As with the North American sample we find that larger and more profitable firms rely more on long-term financing. For tangibility we find coefficient signs concurrent with theoretic rationale, however, they stand in contradiction to our findings for the North American sample. Specifically, firms with higher amounts of tangible assets depend more highly on long-term debt as they have less problems associated with information asymmetries. This finding is also more in line with the reasoning of Faulkender and Petersen (2006). Finally, the green bond indicator displays the same signs as in the previously discussed results. Since we find a positive and significant coefficient on the green bond indicator for the long-term debt component we conclude that green bonds factor into leverage within the long-term debt category. This is what we would expect as the average maturity of our sample green bonds is approximately 8 years.

## 7.6 Debt Specialisation

A review of the academic literature revealed that a standard assumption is the homogeneity of debt in a firm's capital structure. As capital markets grow and become more sophisticated so do the financing channels for firms. The results in the previous sections show that the expansion of accessible capital markets through green bonds affects the overall leverage decision of green bond issuers. In this section we connect the supply argument of Faulkender and Petersen (2006) with the notion of debt heterogeneity as presented by Rauh and Sufi (2010) and Colla et al. (2013). We examine the influence of green bonds on a firm's degree of debt specialisation.

While we do not examine the evolution of the different debt components across time, focusing on our measure of specialisation will allow us to better assess the impact of green bonds on corporate debt structure. Following the words of Rauh and Sufi (2010), *"an analysis that focuses only on total debt misses a substantial fraction of variation in changes in capital structure"*, we now move beyond overall leverage.

### 7.6.1 North America

Table 9 shows the regression results for the North American sample. All specifications have the HHI presented in section 4.2.3 as the dependent variable with various controls being added as one moves from left to right in the table. Given that the dependent variable is bound between 0 and 1 we rely on Tobit estimation across the specifications. As discussed in section 5 this also means that coefficients are not directly interpretable since using maximum likelihood estimation makes the effect of an explanatory variable dependent on its exact value. Following Colla et al. (2013) we thus limit our discussion to the sign of the coefficients and their magnitude relative to each other.

Much like for the leverage regressions presented in table 4 column one presents the base specification with only the fundamental explanatory variables included. Size, profitability, tangibility and market-to-book are all consistent across specifications. As with overall leverage we follow the argumentation by Faulkender and Petersen (2006) i.e. we hypothesise that firm debt structure is not solely being determined by firm demand, but also dependent on supply of debt financing. From early work on green bonds by Flammer (2021) and Tang and Zhang (2020) we know that the issuance of a green bond affects the ownership structure of the firm (at least for equity). While Rauh and Sufi (2010) find that firms with very high credit rating i.e. the least restricted supply of debt capital, have very specialised debt structures, Colla et al. (2013) find that unrated firms will rely on fewer types of debt. While their samples are vastly different these results seem to be add odds with each other. Examining our proxy for expanded capital market access we find a negative association between the issuance of a green bond and debt structure specialisation. This result is fairly robust across specifications and indicates that green bond issuance adds to the complexity of corporate debt holdings rather than exhibiting a *crowding out effect* in which green bonds replace other debt instruments. As

**Table 9: Debt specialisation - North America**

*The dependent variable is the HHI (section 4.2.3). We estimate over the period 2013-2019 using a panel Tobit regression (equation 5). The green bond variable is equal to 1 for all firm-quarters from and including issuance. All specifications control for firm fixed effects. Right-hand side variables have been lagged and follow the definitions of section 4.3*

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| Size | −0.050*** | −0.048*** | −0.044*** | −0.038*** | −0.044*** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Profitability | 0.026*** | 0.010* | 0.032*** | 0.014** | 0.057*** |
| | (0.006) | (0.006) | (0.006) | (0.006) | (0.006) |
| Tangibility | −0.128*** | −0.109*** | −0.090*** | −0.073*** | −0.039*** |
| | (0.004) | (0.004) | (0.005) | (0.005) | (0.005) |
| M/B | 0.020*** | 0.018*** | 0.020*** | 0.014*** | 0.020*** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Green Bond | | −0.078*** | −0.059*** | −0.061*** | −0.057*** |
| | | (0.008) | (0.009) | (0.009) | (0.008) |
| R&D | | | 0.126*** | 0.118*** | 0.155*** |
| | | | (0.013) | (0.014) | (0.012) |
| SG&A | | | 0.054*** | 0.066*** | 0.092*** |
| | | | (0.006) | (0.007) | (0.006) |
| Return on Equity | | | | 0.022*** | 0.018*** |
| | | | | (0.003) | (0.003) |
| Volatility (assets) | | | | 0.244*** | −0.034* |
| | | | | (0.017) | (0.020) |
| Book Leverage | | | | | −0.226*** |
| | | | | | (0.006) |
| Observations | 18,027 | 18,027 | 18,027 | 18,027 | 18,027 |
| BIC | −6,639.5 | −6,650.9 | −6,667.5 | −6,729.5 | −6,982.6 |
| Controls | Firms | Firms | Firms | Firms | Firms |
| Estimation method | Tobit | Tobit | Tobit | Tobit | Tobit |

*p<0.1; **p<0.05; ***p<0.01

our study suffers from the same drawback as Colla et al. (2013)[38], one should be careful in interpreting this finding in the most literal way. We however maintain that this further lends support to the work of both Faulkender and Petersen (2006) as well as Colla et al. (2013) in that capital market access and in this case a new debt instrument, has explanatory value beyond the traditional determinants of firm debt decisions.

Shifting focus onto the other explanatory variables and starting with size, we hypothesise that larger firms suffer less from problems related to information asymmetry and thus one should expect larger firms to be less concerned with the benefits of external monitoring. As shown by Park (2000) monitoring can enhance firm value, but will most likely take place when creditors receive the full benefit from their monitoring activities. Thus, smaller firms who are more likely to benefit from monitoring should, according to theory, have more specialised debt structures to incentivise creditors. We observe a negative and statistically significant association between size and debt specialisation indicating that larger firms do have more diversified debt structures. As the benefit of monitoring becomes secondary for these firms, diversifying becomes more likely. Colla et al. (2013) also document a negative relationship although their estimate is not consistently significant. The result is at odds with the cross-sectional observation made by Rauh and Sufi (2010) who document more diversified debt structures for smaller firms with lower credit ratings. Although, their results are more focused on the priority structure and are therefore not directly comparable.

Firms with tangible assets are expected to have lower costs of bankruptcy since their assets are more easily redeployed. Bolton and Scharfstein (1996) show that a firm's debt structure can affect bankruptcy costs. They present a model in which firms with higher bankruptcy cost *ex ante* can lower these by having a more specialised debt structure. The intuition behind this effect is straightforward. In case of default the firm has fewer external creditors i.e. fewer opposing opinions leading to more efficient renegotiation or liquidation. Based on this we should expect firms with fewer tangible assets to have more specialised debt structures and firms with more tangible assets to be more diversified as their bankruptcy costs are lower *ex post*. From table 9 we observe that the coefficient for tangible assets is negative across the five

[38]Will be elaborated upon in section 8

specifications as well as statistically significant. The magnitude decreases quite substantially once we include book leverage which is unsurprising given that the variables are positively correlated suggesting that some of the negative effect of book Leverage has been captured by tangibility in the first four specifications. Colla et al. (2013) similarly find a negative association between debt specialisation and tangible assets lending support to our finding that firms with more severe bankruptcy costs tend to be more specialised.

Related to the bankruptcy consideration we observe a positive association between market-to-book and the HHI. This is again in line with the study by Colla et al. (2013) although the magnitude is slightly smaller. As discussed earlier, firms with more growth opportunities will tend to avoid too much leverage as default is more costly for them. Similarly, we find that they also tend to be more specialised. Based on Bolton and Scharfstein (1996) we would expect this relationship since having fewer creditors should lower the probability of liquidation as renegotiation is more likely the efficient outcome. Halling et al. (2020) show how this effect is not uniform across the business cycle and that "growth" firms tend to become even more specialised during recessions where the probability of costly default is higher, *ceteris paribus*. For firms with higher costs of liquidation we would similarly expect a heavier reliance on bank debt rather than bonds, since banks are typically more efficient in case of financial distress (Chemmanur and Fulghieri, 1994). Unfortunately the HHI does not allows us to investigate this dynamic of corporate debt structure.

Examining profitability we see a consistent positive coefficient. Colla et al. (2013) find that their coefficient for profitability switches from negative to positive, but provide little explanation for why this occurs. One possible rationale for the positive coefficient can be found by reexamining the pecking order theory. While the traditional theory treats debt as homogeneous, if looking at the many forms of debt, the theory would predict that firms turn to the least informational sensitive types of debt first. Rauh and Sufi (2010) show that profitability is in fact positively correlated with bank debt (least informational sensitive) and very negatively correlated with convertible debt (closest to equity). If firms follow a *within debt pecking order* we would thus expect more profitable firms, for whom the flow of funds deficit suddenly increases, to first exhaust their borrowing limits within e.g. bank debt. Only if needed will

the firms look to other debt sources. Less profitable firms might have a financing deficit of such severe magnitude that they must turn to multiple debt sources in order to service their investment options. Thus, we would expect less profitable firms to have more dispersed debt structures.

From a bankruptcy stand point we would expect profitable firms to have lower probability of default and be less concerned with having a specialised debt structure i.e. a negative relationship. The positive coefficient does not contradict empirical findings as Halling et al. (2020) also report a positive relationship during expansions, however, it is not statistically significant.

Similarly to the leverage regressions in section 7.1 we further test the robustness our results. We once again exclude financial firms and re-run our Tobit regressions. Results are included in appendix 6 and they report that the association between green bond issuance and debt specialisation remains negative and statistically significant. In fact it becomes slightly more pronounced. The consistency across regressions is suggestive of the fact that our results are not being driven by a subset of financial firms who also happen to be green bond issuers.

### 7.6.2 International Sample

As with table 9, table 10 reports the Tobit estimations for the debt specialisation regressions for the international sample. The estimated models are the same as with the North American sample, with the exception of the consideration of R&D expenditure. Once again this variable is not reported through Compustat Global and thus cannot be accounted for within the analysis.

For the green bond indicator we find a consistently negative coefficient, which is also highly statistically significant and remains consistent in magnitude. Firms with access to the sustainable debt market, thus also maintain lower degrees of debt concentration. This statistical relationship indicates that the supply side effects on debt capital markets might be influential in a firm's choice of debt. Given access to the new green debt market, firms on average will also choose to hold different categories of debt.

At first glance the robustness of the size coefficient is particularly noteworthy. The coefficient remains highly statistically significant and the sign remains negative throughout all specifications. This negative correlation is consistent with our previous findings as well as with Colla et al. (2013). These findings lend more credibility to the theoretical conjecture that lower potential for moral hazard problems is associated with a lower degree of debt specialisation. Profitability is mostly statistically insignificant. Only for the full specification does the coefficient become significant with a negative sign. The bankruptcy hypothesis as stated by Colla et al. (2013) would suggest a negative relationship between profitability and specialisation since more profitable firms should be less concerned with the increased bankruptcy costs related to inefficient liquidation from having multiple creditors. While the results for the international sample seem to favour this explanation, these results are not convincing and since the North American results are in direct contradiction it is not straightforward to determine which is more correct. Despite the ambiguous results reported by Colla et al. (2013) they seem to lean more towards a bankruptcy argument.

For all specifications the coefficient for tangibility is positive and statistically significant. This is in direct contrast to the results reported for the North American sample as well as the studies by Colla et al. (2013) and Halling et al. (2020). Revisiting the model by Bolton and Scharfstein (1996) we attempt to relate our findings to the their notion of asset complementarity (i.e. are a firm's assets worth more together than apart?). Traditionally, we would expect most tangible assets to exhibit low complementarity in that they can easily by liquidated individually with little effect on their overall value. In this instance firms lower their expected bankruptcy cost by having a more disperse debt structure. Alternatively, if the tangible assets are highly complementary i.e. have the highest value if liquidated together, then a more specialised debt structure should lower bankruptcy costs (Bolton and Scharfstein, 1996). One possible explanation for the positive coefficient on tangibility for the international sample is that the tangible assets on the firm's balance sheet exhibit higher complementarity compared to the North American sample. An investigation of this hypothesis is, however, out of scope for this study.

**Table 10: Debt specialisation - International sample**

*The dependent variable is the HHI (section 4.2.3). We estimate over the period 2013-2019 using a panel Tobit regression (equation 5). The green bond variable is equal to 1 for all firm-quarters from and including issuance. All specifications control for firm fixed effects. Right-hand side variables have been lagged and follow the definitions of section 4.3*

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| Size | −0.034*** | −0.034*** | −0.034*** | −0.032*** | −0.028*** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Profitability | 0.003 | 0.004 | 0.003 | −0.006 | −0.014* |
| | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) |
| Tangibility | 0.035*** | 0.035*** | 0.036*** | 0.031*** | 0.025*** |
| | (0.007) | (0.007) | (0.007) | (0.007) | (0.007) |
| M/B | 0.032*** | 0.032*** | 0.032*** | 0.026*** | 0.028*** |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) |
| Green Bond | | −0.050*** | −0.050*** | −0.045*** | −0.047*** |
| | | (0.014) | (0.014) | (0.014) | (0.015) |
| SG&A | | | −0.003 | −0.002 | 0.007 |
| | | | (0.007) | (0.007) | (0.007) |
| Return on Equity | | | | 0.021*** | 0.019*** |
| | | | | (0.003) | (0.003) |
| Volatility (assets) | | | | 0.074*** | −0.028 |
| | | | | (0.019) | (0.020) |
| Book Leverage | | | | | −0.161*** |
| | | | | | (0.008) |
| Observations | 19,211 | 19,211 | 19,211 | 19,211 | 19,211 |
| BIC | −4,255.9 | −4,251.8 | −4,242.1 | −4,264.5 | −4,381.2 |
| Controls | Firms | Firms | Firms | Firms | Firms |
| Estimation method | Tobit | Tobit | Tobit | Tobit | Tobit |

*p<0.1; **p<0.05; ***p<0.01

Concerning the market-to-book ratio, the findings are once again very robust. The coefficient stays approximately consistent in terms of sign, significance and magnitude. The observed correlation is positive, indicating that firms with more growth opportunities will also rely on

a smaller set of different debt instruments. This is likely a way for these firms to maintain some degree of financial flexibility.

Finally, analysing the control variables included for columns 3-5, we can see that book leverage is negatively associated with debt specialisation, while R&D (only North America), SG&A, return on equity and volatility of assets are positively correlated with the HHI. The positive association of the last four variables again seem to favour the bankruptcy hypothesis (Colla et al., 2013). Fewer tangible and more volatile assets should increase a company's expected bankruptcy costs, *ceteris paribus*, resulting in increased specialisation. The negative association of book leverage for both samples is suggestive of the fact that firms with relatively high leverage will have to rely on multiple debt sources in order to service their demand for debt financing.

## 7.7 Discussion

Our empirical findings speak to the underlying idiosyncracies of green bond issuing firms. These unique characteristics have an impact on the broader capital market environment and can lead to some interesting implications and considerations for all of the firm's stakeholders. In this section we first outline the main findings of our empirical work, emphasising the unique features of the green bond issuing firms. Mainly we focus on 4 observations made on the basis of our empirical analysis. The observations as outlined in the following are made on the basis of our results from the North American sample, as we deem this dataset to be more reliable, which is also confirmed by the consistency of our findings across robustness checks. Our intention is not to ignore the findings from the international sample; we view them as an additional source for empirical inference, but do acknowledge that the correlations we find might suffer from lower data quality. Therefore, the following observations are made largely on the basis of our North American results, which applies particularly to observations 1. and 4.. On the basis of our key observations we consider the effects these findings might have on the broader market environment and how different stakeholders might be affected by the unique nature of the green bond issuing firms.

Broadly speaking we make four main observations on the basis of our empirical analysis. The observations follow directly from the previously presented regression analysis and act as our contribution to the broader corporate finance literature:

1. Market leverage is higher for green bond issuing firms. Therefore, firms appear to make use of the increased supply offered through the sustainable capital markets if they have the option to do so. Gaining access to the green bond market can hypothetically increase investor supply and scope.

2. The increase in leverage is captured by the long-term component of debt. Green bonds will mainly factor into the debt ratio as long-term debt.

3. Debt specialisation decreases with green bond market access; i.e. green bond issuing firms on average employ a wider range of debt instruments. Controlling for other firm specific characteristics, green bond issuers choose to diversify their channels of debt funding.

4. Green bonds do not crowd out other debt categories meaning that they add to the existing debt. This means that green bonds are mostly added to the other categories of debt, leading to the higher leverage ratios. We do not, however, make any inference on the interaction between green bonds and regular corporate bonds as our analysis does not include this level of granularity due to the available data.

In the following we discuss the implications of these findings for the general financing structure of firms. We relate our hypothesis to concepts within the corporate finance literature, which are also outlined in our review of the literature.

*Supply and demand interaction*

Based on observation 1. if a firm has access to the green bond market they are also more likely to maintain a higher leverage ratio. Thus, it appears that the firms face a supply side constriction if they do not have access to the sustainable capital markets. Assuming that firms make their leverage ratio choices independently, they should also be able to increase the debt supply they face by actively pursuing sustainable projects and thus gaining access to the green

bond market segment. Currently, the green bond market is facing a lot of investor demand, which is not saturated yet (MacAskill et al., 2020). Therefore, firms can make use of this under-supply if they see a need to increase their own leverage. Of course, there are limitations to the kind of firms, that can gain access to this segment of financial markets. Access will vary across several dimensions such as size, industry and geographic reach. Nevertheless, larger, established firms with access to the broader corporate bond market, should be able to shift investments towards green projects in order to increase their scope of prospective investors. Based on this line of argumentation there appears to be some merit to the debt supply side arguments within the corporate finance literature. Faulkender and Petersen (2006) build their arguments around the distinction between public and private debt. In this paper we analyse two types of public debt, constituting an important distinction. The firms in our sample already have access to the public corporate bond market, gaining access to the green bond segment within this market should be feasible for a large subset of them. The classic view is that observed debt levels equal the market demand for debt. As the green bond market matures and grows, we might expect an increasing amount of firms in a more diverse set of industries to enter this market in order to expand their debt supply and meet their demand, if their firm characteristics cause them to need more debt than they currently have access to.

*Considerations of green bond findings for debt theory*

Again referring to observation 1. since green bond issuers maintain higher leverage ratios, we reason that the benefits of issuing a green bond outweigh the costs when viewed through the lens of the trade off theory of debt. Essentially, by taking on further debt the firms expose themselves to a higher cost of bankruptcy as outlined by Kraus and Litzenberger (1973). In this regard it might also be worth highlighting observation 2., which states that green bonds more often than not, contribute to long-term debt. This might be consequential for bankruptcy costs as the repayment and refinancing of green bonds will on average not be as imminent as with other short-term debt securities. Furthermore, green bonds restrict the firm's scope of investments by committing to a sustainable agenda for the allocated funds. This self induced limitation of investment range might force the firm to forgo other profitable projects for the benefit of a less profitable but sustainable project. For a firm to force this set of restrictions onto itself appears counter intuitive when we consider that our sample firms already have

access to the broader corporate bond market and could likely issue regular bonds (given that they do not face debt supply side restrictions) (Flammer, 2021). Again this effect might be exacerbated by the fact that green bonds have an average maturity of around 8 years. By committing to this limitation of investment scope for a longer period of time the long-term financial flexibility of the firm might be inhibited. Furthermore, as evident through observation 3. green bond issuers on average maintain a lower degree of debt specialisation. Given the hypothesis made by Colla et al. (2013) this would further act to increase the expected bankruptcy costs. As a counter argument to these inferences, since green bonds are not used as a primary source of funding, but appear to add to already existing debt (as hypothesised based on observation 4.) it might be more appropriate to assume that the green bond issuing firms find themselves with enough financial flexibility that they can credibly allocate a percentage of their funding exclusively to sustainable projects without facing too much limitation in case of a negative shock to their operations.

Examining the impact of green bonds further, we now focus on agency costs. By committing to sustainable investments through the issuance of green bonds, firms can credibly display their investment agenda to capital markets. As ESG mandates are growing in popularity among investors, this market signal can serve to align investor and firm objectives. This increased transparency on investment policy could theoretically make the firm less dependent on the benefits of monitoring as obtained by the reliance on private debt. Furthermore, it would limit the degree to which agents at the firm can engage in risk shifting, firstly, because their scope of actions are restricted through the commitments made via the green bond issuance and secondly because they will be scrutinised should they default on the green commitment they have made. The costs of issuing the green bond would act to internalise the otherwise tacit agency costs as defined by Jensen and Meckling (1976). Finally, relating the discussion to observation 3. green bond issuers rely on a wider variety of debt instruments. This increases the scope of the stakeholders in the firm. Setting a wider range of investors will likely also increase the amount of scrutiny the firm faces in terms of being transparent about its operations and investments. This might further mitigate agency costs. Considering both the hypothesised benefits and disadvantages green bond issuers face, the benefits appear to outweigh the costs, as firms with access to the green bond market maintain a higher level of debt.

*Implications of the debt specialisation pattern among green bond issuers*

As analysed by Flammer (2021) certified green bonds contain a credible signal, which should alleviate information asymmetries between investors and agents of the firm. Additionally, the green bond issuance announcement is associated with positive CAR for the firm's equity. If a firm believes its equity to be undervalued it could theoretically make use of this abnormal market reaction to rebalance its equity valuation. These benefits should make green debt preferred to conventional debt. If we assume that firms follow a strict order of issuance, then we would expect firms with green bond market access to exhaust their ability to issue green debt before they move on to conventional debt. This hypothesis is not straightforward given that green bonds of course also come with the drawback of inhibiting financial flexibility. Nevertheless, under this hypothesis we would assume that some degree of a crowding out effect would take place, wherein certain debt categories are displaced for the benefit of green bond issuances. As stated in observation 4. we do not find that green bonds act as a substitute to the other debt categories. Given the relative infancy of the green bond market, a drastic crowding out effect does not appear to be a realistic observation at this point in time. Furthermore, as found by Flammer (2021) the positive effect of a green bond issuance is more pronounced for first-time issuers. Thus, while green bond issuers are likely to commit to additional green bond issuances (Almeida, 2020), the green bond signalling value relative to other debt instruments will likely diminish over time making green bonds' placement in the debt financing hierarchy a question warranting further investigation.

*Certification and investment*

Observations 1 and 4 indicate that funds allocated for specific sustainable purposes are put on top of the normal corporate activities. As discussed previously, by limiting the scope for which a company can allocate raised funds additional costs are likely to arise. Sufi (2009) distinguishes between *certification* and *monitoring* cost. The first category relates to understanding the reputation of the borrower as well as the project being funded while the second category relates to the follow-up work being undertaken post issuance. The less well known or established the issuing firm is, the more material these costs might be as an outside creditor will need to allocate substantial resources for both certification and monitoring. More generally, the amount of *uninformed capital* a firm has access to has direct impact on its investment

activities (Sufi, 2009). For conventional debt, credit ratings serve to decrease the amount of uninformed capital and lower the issuance cost of firms and thereby spark investment. Since sustainable investing is likely to be more common practice for a variety of firms going forward it is important that green bonds do not become a debt instrument only available to large well-known firms.

Our approach has been based on the assumption that a green bond issuer also has conventional bonds on its balance sheet. Given the importance of sustainable corporate investing we see no reason why firms must first have established themselves in traditional public debt markets before having access to green bonds. Nevertheless, a firm without access to conventional bonds will most likely only have access to uninformed capital and thus have much higher cost associated with issuing a green bond. This is detrimental to the sustainable investment activities of firms. As reported by Flammer (2021) third-party certification of a green bond has material informational value in equity markets. This suggests that certification could prove vital in the efforts of less informationally transparent firms to establish themselves in capital markets. Unfortunately, as highlighted in section 2.2 green bond certification is at a even earlier stage than the overall green bond market. This is likely preventing some firms from actually accessing this new source of financing which is ultimately hurting the corporate green agenda. While certification comes at a cost as well, this should prove insignificant compared to the lowering of both verification and monitoring costs incurred by creditors who ultimately price those into the green bond. The market for green bonds is still dwarfed by conventional bonds, but our results are suggestive of the fact that corporate green bonds are being incorporated into the debt structure of firms. While the establishment of unified standards is generally viewed as being key to establishing a greater market for sustainable debt instruments, we argue that companies themselves should have a great interest in aiding the common practice of certification. This is rooted in the informational value thereof and the impact it will have on firm investment activities.

*Maturity structure impact of green bonds*

Observation 2. highlights the positive impact of a green bond issuance on long-term leverage, while short-term leverage is either not affected or, for the international sample, reduced by the

presence of a green bond in the corporate debt structure. While we, to some extent, view this finding as being the direct result of the longer maturity on green bonds, we pose the question of why this is the case. As previously discussed it has, traditionally in the corporate finance literature, been the view that reliance on short-term debt could limit certain agency costs (Myers, 1977) as well as discipline managers more rigorously than long-term debt, thereby alleviating the free cash flow problem stated by Jensen (1986). As short-term debt needs to be refinanced more frequently this introduces rollover risk. Much like in Diamond (1991) new debt issuances will depend on the information available in the market i.e. it cannot be assumed that debt is rolled over at par value. This might result in rollover losses. Traditional literature works with the assumption that such rollover losses can be covered by equity owners (e.g. Leland, 1998). Given this assumption short-term debt is found to alleviate certain agency costs of debt.[39]

The loosening of this assumption in more recent work highlights how heavy reliance on short-term debt might in fact increase risk-shifting incentives (Della Seta et al., 2020). This occurs since firms with more short-term financing who temporarily become unprofitable face larger rollover losses given the greater fraction of debt that needs to be rolled over. As a result, equity owners become incentivised to increase the risk of the firm i.e. gamble to avoid default. Since the incentive arises for equity owners before debtholders[40] agency costs of debt become present even for short-term debt. Given that green bonds are more restrictive in terms of investment opportunities this adds to the default probability if a firm becomes temporarily unprofitable. From a firm value perspective it thus makes sense to make green bonds a long-term debt instrument, so as to not compound on the effects presented by Della Seta et al. (2020). The discussion above suggests that green bonds (given their nature) somewhat alleviate the risk-shifting possibilities of equity owners. Having green bonds being continuously repriced in the market still increases the likelihood of rollover losses which in turn would be detrimental to the green investing activities of the firm. Thus, for a firm committed to a more sustainable agenda, we would expect green bonds to be a long-term debt component.

[39]Leland (1998) confirms the prediction by Myers (1977), but also states that the agency costs related to asset substitution are easily out-weighed by the tax benefits of debt

[40]In the model by Della Seta et al. (2020) they show how debtholders also have an incentive to increase the risk of the firm, however, much later than equity owners, thus agency conflicts arise

# 8 Limitations and Implications for Further Research

In this section we elaborate on some of the shortcomings we have identified within our analysis. The aim is to provide some transparency on the improvements that can be made on our methodology even if the required methods, models and datasets are not at our disposal at the time of writing. Finally, we hope that the identification of possible flaws within our analysis can inform future research and contribute to creating more robust and reliable findings.

*Causality vs Correlation*

It is important to outline that the analysis performed in this paper is limited in its explanatory power. As will become even clearer through the limitations we discuss in the following, our methodology suffers some drawbacks, which make it infeasible for us to single out certain effects and interactions of specific variables. Due to this limitation we acknowledge that the relationships we have reported throughout our results section are correlations and do not necessarily imply causality. The relationships as summarised in our four key observations are thus not to be interpreted as being uniquely attributed to the issuance of green bonds, but rather features unique to green bond issuing firms. The distinction between correlation and causality is important to be made in this case as establishing causal effects is necessary to make clear actionable recommendations to capital market participants. Given this limitation we look forward to future research that can employ more granular datasets or more sophisticated analytical approaches and in turn can clarify the interactions we have observed more clearly and establish clear causal links. This research is, however, beyond the scope of our paper.

*Endogeneity*

As pointed out by Colla et al. (2013) the analysis in this paper suffer from endogeneity as we are not able to uniquely single out the different effects measured by our model specification. An important assumption within the OLS framework is that of exogeneity of the regressor variables. Endogeneity describes the situation in which the regressors are correlated with the error term in a meaningful manner. For OLS estimation to be consistent, this assumption is essential. The correlation between the error term and the regressor variables can be

driven by simultaneity, an omitted variable bias, an unobserved variable or many other factors (Wooldridge, 2015; Wooldridge, 2010). The main concern within our framework is the fact that access to the green bond market and determinants for having issued a green bond will be dependent on many firm characteristics unaccounted for in our model. For instance the exact nature of any firm's operations will be vital in deciding, whether a firm can issue a green bond and it might affect the leverage a firm chooses to maintain. We try to account for such factors by performing robustness checks as in the previously outlined industry dummy regression but we cannot assume that all such factors are fully accounted for. An example of an unobservable variable is company age. Compustat's dataset has made it unfeasible for us to calculate the age for enough of our sample firms to include it in our regression analysis. Firm age will likely be an important metric to capture the degree to which a firm has built a reputation and relationships with capital markets. This in turn will affect access to different segments of the market and could influence the overall leverage a company chooses to have. Therefore, we acknowledge that our findings are not strictly distinguishable and our coefficients might include effects we are not able to account for. Future research and the emergence on more granular green bond data will be able to scrutinise our findings more rigorously.

*Green Bond Data*

The novelty of the green bond market creates some technical problems when trying to perform analysis on this segment of the capital markets. Firstly, the sample of green bond issuers does not offer a very large pool of firm-quarter observations within our panel dataset. The general market segment is still very small compared to the overall public debt market and most green bonds have been issued within the final years of our sample. As the market matures and market supply increases over time the amount of green bond issuer observations will increase, which in turn will accentuate the statistical relationships of interest.

Secondly, we follow the rationale of Flammer (2021) to define the universe of green bond issuers on the basis of Bloomberg's Fixed Income database. Bloomberg classifies green bonds on the basis of a proprietary assessment method. While likely to encompass the vast majority of the total green bond environment we cannot exclude the possibility that certain observations might be missing from the sample we extract from Bloomberg. This problem also ties in with the lack of a unified classification system for green bonds generally. Having an institutionalised

method for identification of green bonds would increase the integrity of the dataset used for analysis, making results more reliable. Additionally, it would increase the ability to distinguish different effects from each other as the OLS exogeneity assumption would be more easily met and the identification of relevant control variables would also be more clear. Further relevant control variables would be easier to identify as the green bond certification would most likely entail a clear descriptions on the bond characteristics which constitute a green bond, which in turn would shed some light on firm characteristics one would want to control for when assessing the relationship between leverage and green bond issuance.

Furthermore, it would be interesting to perform a similar analysis on other types of ESG related debt instruments. For instance having clear distinctions between green bonds and social bonds would allow for some interesting analysis on the different impacts these securities have on firm ESG performance and investor sentiment.

*Sample construction & Data collection*

As explained in detail in the sample construction section we have faced some difficulties in obtaining the exact data we would require to most rigorously perform our analysis. Specifically, Compustat splits the data it provides into a North American sample and into a Global sample, wherein the North American subset appears to have less missing observations. Some metrics such as R&D expenditure are not available on a quarterly frequency for the global sample forcing us to omit this variable from our estimations.

Another difficulty prominent in our international sample is the lack of observations for banks and financial firms. These firms are often missing a key metric such as total asset value throughout the sample period, making them unusable for our leverage regression. These firms, however, are important contributors to the overall green bond market and could substantially impact the outcome of our estimations. For similar reasons we are forced to restrict our international sample to firms present in only a few select geographic areas. Most importantly China is omitted from our analysis due to data availability. When discussing our findings we must acknowledge that the inclusion of these missing data points could substantially add to the explanatory power of our analysis. Given the limited access to data in Compustat we have tried to cast as wide a net as possible in order to construct our regression samples, but improvements can be made as more data emerges in terms of amount and granularity.

A final point of contention is the combination and cross identification of entities across Bloomberg, Compustat and other databases. Since there is no unified metric of identification, we lose observations when trying to obtain company data through Compustat based on tickers retrieved from Bloomberg. Thus linking these two datasets is not entirely without frictions. Having manually cross referenced the firms obtained from both datasets we suspect that common identifiers between the two datasets would substantially increase the scope of projects that can be performed on datasets compiled from both data repositories. For instance not having to manually scan for misclassifications among the green bond issuers would substantially increase the scope of firms with which future researchers can perform a similar analysis.

*Market access measurement*

For this paper we measure the access to sustainable capital markets by the observation if a firm has issued a green bond. This is, however, not a perfect proxy for market access as a subset of firms might exist, which have access to the green bond market, but have not issued in this market for specific reasons. Thus, further analysis should investigate the determinants of market access and leverage these determinants to find an alternative proxy for market access. Intuitively, this metric would consist of a number of different factors and cannot be broken down to a single firm characteristic. While conceptualising the modelling for this paper we have also hypothesised that a company's ESG score might be a suitable metric for market access. Many of the previously reported regressions could be run with ESG scores instead of our green bond indicator. The reason we have not been able to perform this analysis in this thesis is again technical in nature. The two main providors of ESG scores currently are Bloomberg and Thomson Reuter's ASSET4 database. Nevertheless, many firms still remain unrated, making it infeasible for us to construct a meaningful sample on which to perform a regression analysis on. Alternatively, a proprietary ESG score could be constructed on the basis of key firm metrics such as CO2 emissions or diversity in leadership roles, however, this goes beyond the scope of this paper.

*Building on green results*

An implicit assumption in our model is that firms choose their debt structure independently and solely on the basis of specific firm characteristics (e.g. green bond market access, size, profitability, etc). Halling et al. (2020) find that firms adjust their leverage choices depending on the macroeconomic environment. The authors even go a step further and analyse the interaction of the business cycle with debt specialisation. For instance they find that firms rely on a wider variety of debt sources during recessions. These considerations could also be incorporated into the analysis performed in this paper. Adding this distinction between boom and bust cycles could lead to some interesting findings on when firms choose to issue green bonds. Since the funds obtained through green bonds face a limited scope of projects they can be invested in, we might expect firms to be more likely to issue green bonds during boom cycles as their need for financial flexibility is not as imminent as during periods of economic difficulty. Such an analysis would, however, require a longer sample period than 7 years, which is currently not feasible given the novelty of the corporate green bond market. The use of a longer sample period is necessary to create clear distinctions between boom and bust cycles. Additionally, expanding the time series of the data will allow future researches to investigate the rolling over of green debt. It will be interesting to determine, whether the proportion of green debt will tend to swell or shrink for the issuing firms and how the proportion of green leverage interacts with the business cycle.

Lastly, our paper follows the vast majority of green bond literature by being of empirical nature rather than theoretical. Thus, all major findings are related to traditional debt theory. As is common within other areas of finance we expect the empirical literature to outweigh theoretical contributions by a substantial factor. In the early days of green bond literature the fundamentals of traditional debt and capital theory will certainly be relied on for inference on green debt findings. Going forward the need for theoretical work, which can encompass the unique features of green bonds and their surrounding environment will, however, remain present.

# 9 Conclusion

The aim of this thesis is to investigate the impact of the rapidly growing green bond market on firms' debt financing decisions through the questions outlined in the introduction. Above all the analysis' objective is to provide insights into the interaction of debt financing decisions and access to the green bond market. Our empirical findings suggest some interesting relationships and determinants of debt choices, unique to firms with green bond market access. These are summarised in our four main findings.

In a broad sense, the first observation relates green bond market access to firms' leverage ratios. The results for the North American sample show that green bond issuing firms do in fact maintain a higher ratio of total debt to its market value of assets. Firms facing increased debt supply via the green capital market, therefore, appear to make use of this debt supply in a noteworthy way. This inference is, however, not confirmed for our sample of international firms. Here we find no significant relationship between green bond market access and overall leverage. The lack of statistical significance might be driven by a lack of green bond observations in our international sample and thus constitutes an important area for further research. For this reason, we expand upon our analysis by employing alternative estimation methods, which in fact echo our findings for the North American sample more closely. Interpreting these findings too much may lead to ill informed inferences, but we do conclude that the international sample findings do not stand in contrast to the North American ones, even if they do not necessarily verify the same conclusions.

We examine firm leverage in more detail by distinguishing long-term from short-term debt. Here, across both samples, we find that green bond market access significantly increases the long-term debt component when scaled by total debt. Green bonds on average are long-term debt instruments, making this finding intuitive. Another interesting discovery can again be found in the international sample. We find a significant and negative coefficient for the short-term market leverage. As firms obtain green bond market access they might hypothetically be replacing other short-term debt with green debt, hinting at a substitution effect. Furthermore, within this sample, the substitution effect might explain why overall leverage is not significantly affected by green bond market access as these firms do not increase overall leverage but simply

retire existing short-term debt for the benefit of new green debt. While these results open up some interesting avenues for further research, this substitution conjecture would also need to be investigated in more detail and verified independently.

Finally, we shift our focus onto the interplay between green bond market access and other debt categories. We measure the degree to which a firm's debt is specialised within specific debt categories by a HHI and use this metric as well as the independent variables of the leverage regressions to answer our question concerning firm's attitude towards other debt categories after issuing a green bond. Across different samples and model specifications we find that green bond issuers on average maintain a lower degree of debt specialisation. This leads us to believe that, controlling for firm characteristics, firms with access to the green bond market spread their debt across a larger array of debt instruments.

This thesis is an initial investigation into corporate debt structure choices through the lens of the newly emerging green bond market. We see our contribution as a starting point upon which a lot more analysis can be built to specifically identify and distinguish the unique decisions made by green bond issuing firms. Most valuable to these future analyses will be the emergence of more and increasingly granular data. Additionally, as more firms enter this market segment we might expect some of the relationships documented in this paper to change over time.

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# 11 Appendices

## 11.1 Appendix 1: Econometric Tests and Robust Standard Errors

### Econometric Tests

We perform the econometric tests as explained in section 5.3 on all specifications of the leverage regressions in section 7. The test results indicate which estimation method is most appropriate for the analysis. Additionally, the tests allow us to investigate the appropriateness of the model specifications as outlined in section 5 more rigorously. Overall, we confirm that using fixed effects estimation for our models is most appropriate.

Starting with the North American sample, we firstly perform the Breusch Pagan test for homoskedasticity in the idiosyncratic error term, $u_i$. The null hypothesis of the test is no heteroskedasticity and the test static follows a Chi-distribution with k degrees of freedom as described in section 5.3. Across all model specifications we find significant levels of heteroskedasticity (at the 1% level), meaning that we reject the pooled OLS regression method as the most appropriate mode of estimation.

With this finding we move on to determine whether random effects or fixed effects estimation should be used. For this purpose we employ the Hausman test to assess the difference in parameter estimates. The null states no correlation between the between the time invariant part of the error term, $a_i$, and the explanatory variables. If we are not able to reject the null random effects estimation will be more efficient. The test statistic is calculated as:

$$H = \left(\hat{\delta}_{RE} - \hat{\delta}_{FE}\right)' \left(Var\left(\hat{\delta}_{RE}\right) - Var\left(\hat{\delta}_{FE}\right)\right) \left(\hat{\delta}_{RE} - \hat{\delta}_{FE}\right)$$

Where $\hat{\delta}_{RE}$ and $\hat{\delta}_{FE}$ are the $k \times 1$ vectors of random and fixed effects estimators respectively. The test statistic follows are Chi-squared distribution with k degrees of freedom.
Again we find significant differences consistently at the 1% level, indicating that random effects estimation is inconsistent.

Finally, we compare fixed effects estimation to first difference estimation, by following the test proposed by Wooldridge (2015). To perform the test we first run a first difference regressions and following that we regress the residuals on their lagged values:

$$\Delta y_{i,t} = \beta_1 \Delta x_{i,t} + \Delta u_{i,t}$$

$$\Delta u_{i,t} = \delta_1 \Delta u_{i,t-1} + error_{i,t}$$

The results builds on the finding by Wooldridge (2015) that if the lagged first-difference errors are serially correlated, then the level errors, $u_{i,t}$ will be serially uncorrelated. The null hypothesis for the level errors us therefore stated as follows:

$$H_0 : \rho_{u_{i,t}, u_{i,t-1}} = 0$$

The test indicates the prevalence of significant serial correlation in the first differenced idiosyncratic error term suggesting that fixed effects estimation is appropriate. As the choice between first difference and fixed effects is rarely clear-cut we report our fixed effects estimations with Newey-West standard errors.

We perform the same three sets of tests on the data of the international sample. The Breusch Pagan test again reveals that the data displays heteroskedastic error terms (at the significance level of 1%), meaning that we reject the pooled OLS estimation as the model of choice. The Hausman test finds significant correlation between the idiosyncratic error term and the regressor variables, making the random effects estimation inconsistent (at the significance level of 1%). Finally, the first difference residuals are significantly correlated at the 1% level.
The conclusion following from these tests is the same as with the North American sample and we decide to employ fixed effects estimation.

**Robust Standard Errors**

Given the fact that the data employed in this paper will contain certain random factors which cloud the decisiveness of our econometric testing, we acknowledge that the models we use might suffer from serial correlation or heteroskedasticity. For this reason we report our main leverage regressions in section 7 with robust standard errors.

More specifically by reporting our results with standard errors which follow the Newey-West procedure we account for serial correlation as well as arbitrary heteroskedasticity (Wooldridge, 2015). As the theory underlying the exact computation of these adjusted standard errors is rather technical in nature we do not elaborate further. Less rigorous standard errors are reported for some regressions; more specifically the White heteroskedastic robust standard errors. As serial correlation is more likely to be an issue for fixed effects estimation we employ Newey-West standards errors for all fixed effects regressions and White standard errors for the remaining estimation methods.

## 11.2 Appendix 2: Market Leverage Regression - First Difference

**Table 11: Determinants of market leverage: International sample - First Difference**

*The dependent variable is the ratio of total debt (long-term + short-term) to the market value of assets (section 4.2.1). We estimate over the period 2013-2019 using a panel regression (equation 3) in first difference. The green bond variable is equal to 1 for all firm-quarters from and including issuance. All specifications are performed on a first difference estimation. Additional controls follow the definitions of section 4.3. We report White standard errors in brackets.*

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| Profitability | −0.001 | −0.001 | −0.001 | −0.001 | 0.001 |
| | (0.003) | (0.003) | (0.003) | (0.003) | (0.003) |
| Size | 0.003 | 0.003 | 0.003 | 0.003 | 0.022** |
| | (0.011) | (0.011) | (0.011) | (0.011) | (0.010) |
| Tangibility | 0.227*** | 0.227*** | 0.227*** | 0.229*** | 0.220*** |
| | (0.033) | (0.033) | (0.033) | (0.034) | (0.032) |
| M/B | −0.032** | −0.032** | −0.032** | −0.032** | −0.028** |
| | (0.013) | (0.013) | (0.013) | (0.013) | (0.012) |
| Green Bond | | 0.020*** | 0.020*** | 0.021*** | 0.020*** |
| | | (0.007) | (0.007) | (0.007) | (0.007) |
| SG&A | | | −0.001 | −0.0004 | −0.0002 |
| | | | (0.002) | (0.002) | (0.002) |
| Short-term Debt | | | | 0.016*** | |
| | | | | (0.005) | |
| Return on Equity | | | | | −0.029*** |
| | | | | | (0.002) |
| Volatility (assets) | | | | | −0.175*** |
| | | | | | (0.018) |
| Observations | 28,723 | 28,723 | 28,723 | 28,721 | 28,723 |
| $R^2$ | 0.083 | 0.083 | 0.083 | 0.086 | 0.142 |
| Controls | Firm | Firm | Firm | Firm | Firm |
| Estimation Method | Difference | Difference | Difference | Difference | Difference |

*p<0.1; **p<0.05; ***p<0.01

## 11.3 Appendix 3: Book Leverage Regressions

### Table 12: Determinants of book leverage - North America

*The dependent variable is the ratio of total debt (long-term + short-term) to the book value of assets (section 4.2.1). We estimate over the period 2013-2019 using a panel regression (equation 3). The green bond variable is equal to 1 for all firm-quarters from and including issuance. All specifications control for firm fixed effects. Additional controls follow the definitions of section 4.3. We report Newey-West standard errors in brackets.*

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| Profitability | −0.020* | −0.020* | −0.034*** | −0.039*** | −0.015 |
| | (0.011) | (0.011) | (0.012) | (0.012) | (0.010) |
| Size | 0.076*** | 0.076*** | 0.075*** | 0.058*** | 0.060*** |
| | (0.004) | (0.004) | (0.005) | (0.006) | (0.004) |
| Tangibility | 0.244*** | 0.243*** | 0.243*** | 0.256*** | 0.202*** |
| | (0.037) | (0.036) | (0.036) | (0.036) | (0.030) |
| M/B | −0.013*** | −0.013*** | −0.013*** | −0.008*** | −0.012*** |
| | (0.002) | (0.002) | (0.002) | (0.003) | (0.002) |
| Green Bond | | 0.016* | 0.016* | 0.018** | 0.007 |
| | | (0.008) | (0.008) | (0.008) | (0.008) |
| R&D (%) | | | −0.010 | −0.005 | 0.031 |
| | | | (0.036) | (0.034) | (0.030) |
| SG&A (%) | | | −0.052* | −0.050* | −0.072*** |
| | | | (0.030) | (0.029) | (0.026) |
| Short-term Debt (%) | | | | −0.052*** | |
| | | | | (0.009) | |
| Return on Equity | | | | | −0.006** |
| | | | | | (0.003) |
| Volatility (assets) | | | | | −0.981*** |
| | | | | | (0.050) |
| Observations | 21,058 | 21,058 | 21,058 | 20,548 | 20,057 |
| $R^2$ | 0.094 | 0.094 | 0.095 | 0.079 | 0.236 |
| Controls | Firm | Firm | Firm | Firm | Firm |
| Estimation Method | Within | Within | Within | Within | Within |

*p<0.1; **p<0.05; ***p<0.01

**Table 13: Determinants of book leverage - International sample**

*The dependent variable is the ratio of total debt (long-term + short-term) to the book value of assets (section 4.2.1). We estimate over the period 2013-2019 using a panel regression (equation 3). The green bond variable is equal to 1 for all firm-quarters from and including issuance. All specifications control for firm fixed effects. Additional controls follow the definitions of section 4.3. We report Newey-West standard errors in brackets.*

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| Profitability | −0.021** | −0.021** | −0.020** | −0.021** | −0.014* |
| | (0.009) | (0.009) | (0.009) | (0.009) | (0.008) |
| Size | 0.051*** | 0.051*** | 0.051*** | 0.051*** | 0.054*** |
| | (0.007) | (0.007) | (0.007) | (0.007) | (0.006) |
| Tangibility | 0.368*** | 0.368*** | 0.368*** | 0.367*** | 0.345*** |
| | (0.033) | (0.033) | (0.033) | (0.033) | (0.033) |
| M/B | −0.019*** | −0.019*** | −0.019*** | −0.019*** | −0.017*** |
| | (0.007) | (0.007) | (0.007) | (0.007) | (0.006) |
| Green Bond | | 0.002 | 0.002 | 0.002 | −0.0004 |
| | | (0.012) | (0.012) | (0.012) | (0.012) |
| SG&A (%) | | | 0.001 | 0.001 | 0.001 |
| | | | (0.006) | (0.006) | (0.006) |
| Short-term Debt (%) | | | | −0.009 | |
| | | | | (0.007) | |
| Return on Equity | | | | | −0.008*** |
| | | | | | (0.002) |
| Volatility (assets) | | | | | −0.386*** |
| | | | | | (0.033) |
| Observations | 30,489 | 30,489 | 30,489 | 30,487 | 30,489 |
| $R^2$ | 0.103 | 0.103 | 0.103 | 0.104 | 0.157 |
| Controls | Firm | Firm | Firm | Firm | Firm |
| Estimation Method | Within | Within | Within | Within | Within |

*p<0.1; **p<0.05; ***p<0.01

## 11.4 Appendix 4: Correlation Matrices

### Table 14: Correlation Matrix - North America

*The table displays the correlation between the explanatory variables described in section 4.3 and used in section 7. The correlation is taken across the entire sample period 2013-2019.*

| | Size | Profit ability | Tangible | M/B | Green Bond | R&D | SG&A | Short-term | Return on Equity | $\sigma$ (Assets) |
|---|---|---|---|---|---|---|---|---|---|---|
| Size | 1 | | | | | | | | | |
| Profitability | 0.178 | 1 | | | | | | | | |
| Tangibility | 0.027 | 0.113 | 1 | | | | | | | |
| M/B | 0.069 | −0.191 | −0.145 | 1 | | | | | | |
| Green Bond | 0.157 | 0.050 | 0.041 | −0.037 | 1 | | | | | |
| R&D | −0.060 | −0.302 | −0.233 | 0.482 | −0.024 | 1 | | | | |
| SG&A | −0.120 | −0.267 | −0.377 | 0.397 | −0.024 | 0.501 | 1 | | | |
| Short-term | 0.090 | 0.078 | −0.222 | −0.005 | 0.098 | −0.014 | 0.103 | 1 | | |
| Return on Equity | 0.003 | −0.046 | −0.100 | 0.283 | −0.013 | 0.113 | 0.117 | 0.023 | 1 | |
| $\sigma(Assets)$ | −0.290 | −0.171 | 0.102 | 0.039 | −0.052 | 0.186 | 0.104 | −0.044 | 0.085 | 1 |

### Table 15: Correlation Matrix - International sample

*The table displays the correlation between the explanatory variables described in section 4.3 and used in section 7. The correlation is taken across the entire sample period 2013-2019.*

| | Size | Profit ability | Tangible | M/B | Green Bond | SG&A | Short-term | Return on Equity | $\sigma$ (Assets) |
|---|---|---|---|---|---|---|---|---|---|
| Size | 1 | | | | | | | | |
| Profitability | 0.337 | 1 | | | | | | | |
| Tangibility | 0.077 | 0.185 | 1 | | | | | | |
| M/B | 0.122 | −0.030 | −0.182 | 1 | | | | | |
| Green Bond | 0.157 | 0.050 | 0.041 | −0.037 | 1 | | | | |
| SG&A | −0.246 | −0.383 | −0.112 | 0.129 | −0.029 | 1 | | | |
| Short-term | −0.298 | −0.197 | −0.115 | −0.104 | −0.040 | 0.081 | 1 | | |
| Return on Equity | 0.028 | 0.087 | −0.021 | 0.153 | 0.002 | −0.050 | −0.005 | 1 | |
| $\sigma(Assets)$ | −0.199 | −0.045 | −0.029 | −0.005 | −0.032 | 0.058 | 0.094 | 0.211 | 1 |

## 11.5 Appendix 5: Maturity Structure - First Difference

**Table 16: Maturity structure effects: International sample - First difference**

*In columns 1-2 the dependent variable is the ratio short-term and long-term debt to the market value of assets (section 4.2.2). In columns 3-4 the denominator is total debt (short-term + long-term). We estimate over the period 2013-2019 using a first a panel regression (equation 3) in first difference. The green bond variable is equal to 1 for all firm-quarters from and including issuance. All specifications control for firm fixed effects. Additional controls follow the definitions of section 4.3. We report White standard errors in brackets.*

| | *Scaled by market assets* | | *Scaled by total debt* | |
|---|---|---|---|---|
| | Short-term | Long-term | Short-term | Long-term |
| | (1) | (2) | (3) | (4) |
| Profitability | $-0.009^{***}$ | $0.009^{**}$ | $-0.013$ | 0.013 |
| | (0.003) | (0.003) | (0.008) | (0.008) |
| Size | 0.002 | 0.001 | $-0.028^{*}$ | $0.028^{*}$ |
| | (0.004) | (0.010) | (0.015) | (0.015) |
| Tangibility | $0.053^{***}$ | $0.174^{***}$ | $-0.104^{***}$ | $0.104^{***}$ |
| | (0.016) | (0.030) | (0.038) | (0.038) |
| M/B | $-0.009^{***}$ | $-0.023^{**}$ | $0.018^{*}$ | $-0.018^{*}$ |
| | (0.002) | (0.011) | (0.010) | (0.010) |
| Green Bond | $-0.011^{**}$ | $0.031^{***}$ | $-0.084^{*}$ | $0.084^{*}$ |
| | (0.006) | (0.008) | (0.044) | (0.044) |
| Observations | 28,723 | 28,723 | 28,721 | 28,721 |
| $R^2$ | 0.019 | 0.105 | 0.016 | 0.016 |
| Controls | Firm | Firm | Firm | Firm |
| Estimation method | FD | FD | FD | FD |

$^{*}$p<0.1; $^{**}$p<0.05; $^{***}$p<0.01

## 11.6 Appendix 6: Specialisation Excluding Financial Firms

**Table 17: Debt specialisation excluding financial firms - North America**

*The dependent variable is the HHI (section 4.2.3). We estimate over the period 2013-2019 excluding financial firms (SIC 6000-6999) using a panel Tobit regression (equation 5). The green bond variable is equal to 1 for all firm-quarters from and including issuance. All specifications control for firm fixed effects. Right-hand side variables have been lagged and follow the definitions of section 4.3*

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| Size | −0.053*** | −0.053*** | −0.050*** | −0.043*** | −0.040*** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Profitability | 0.035*** | 0.041*** | 0.060*** | 0.044*** | 0.067*** |
| | (0.008) | (0.008) | (0.008) | (0.007) | (0.008) |
| Tangibility | −0.132*** | −0.131*** | −0.109*** | −0.091*** | −0.016** |
| | (0.005) | (0.005) | (0.006) | (0.006) | (0.006) |
| M/B | 0.024*** | 0.024*** | 0.021*** | 0.014*** | 0.018*** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Green Bond | | −0.079*** | −0.082*** | −0.086*** | −0.071*** |
| | | (0.009) | (0.009) | (0.009) | (0.010) |
| R&D | | | 0.117*** | 0.112*** | 0.148*** |
| | | | (0.014) | (0.015) | (0.016) |
| SG&A | | | 0.049*** | 0.068*** | 0.105*** |
| | | | (0.008) | (0.008) | (0.008) |
| Return on Equity | | | | 0.020*** | 0.015*** |
| | | | | (0.003) | (0.003) |
| Volatility (assets) | | | | 0.254*** | −0.090*** |
| | | | | (0.020) | (0.026) |
| Book Leverage | | | | | −0.322*** |
| | | | | | (0.007) |
| Observations | 14,486 | 14,486 | 14,486 | 14,486 | 14,486 |
| BIC. | −4,634.6 | −4,648.9 | −4,660.7 | −4,700.8 | −4,974.2 |
| Controls | Firms | Firms | Firms | Firms | Firms |
| Estimation method | Tobit | Tobit | Tobit | Tobit | Tobit |

*p<0.1; **p<0.05; ***p<0.01

**Table 18: Debt specialisation excluding financial firms - International sample**

*The dependent variable is the HHI (section 4.2.3). We estimate over the period 2013-2019 excluding financial firms (SIC 6000-6999) using a panel Tobit regression (equation 5). The green bond variable is equal to 1 for all firm-quarters from and including issuance. All specifications control for firm fixed effects. Right-hand side variables have been lagged and follow the definitions of section 4.3*

| | (1) | (2) | (3) | (4) | (5) |
|---|---|---|---|---|---|
| Size | −0.034*** | −0.034*** | −0.034*** | −0.033*** | −0.027*** |
| | (0.001) | (0.001) | (0.001) | (0.001) | (0.001) |
| Profitability | 0.003 | 0.004 | 0.003 | −0.006 | −0.013* |
| | (0.008) | (0.008) | (0.008) | (0.008) | (0.008) |
| Tangibility | 0.035*** | 0.035*** | 0.036*** | 0.031*** | 0.025*** |
| | (0.007) | (0.007) | (0.007) | (0.007) | (0.007) |
| M/B | 0.032*** | 0.032*** | 0.032*** | 0.026*** | 0.028*** |
| | (0.002) | (0.002) | (0.002) | (0.002) | (0.002) |
| Green Bond | | −0.050*** | −0.050*** | −0.045*** | −0.047*** |
| | | (0.014) | (0.014) | (0.014) | (0.015) |
| SG&A | | | −0.003 | −0.002 | 0.006 |
| | | | (0.007) | (0.007) | (0.007) |
| Return on Equity | | | | 0.021*** | 0.019*** |
| | | | | (0.003) | (0.003) |
| Volatility (assets) | | | | 0.073*** | −0.029 |
| | | | | (0.019) | (0.020) |
| Book Leverage | | | | | −0.162*** |
| | | | | | (0.008) |
| Observations | 19,199 | 19,199 | 19,199 | 19,199 | 19,199 |
| BIC | −4,243.2 | −4,239.2 | −4,229.4 | −4,251.9 | −4,369.0 |
| Controls | Firms | Firms | Firms | Firms | Firms |
| Estimation method | Tobit | Tobit | Tobit | Tobit | Tobit |

*p<0.1; **p<0.05; ***p<0.01