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Is there a green bond premium in the Nordic countries?

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ABSTRACT:

The thesis concentrates on the yield difference between green bonds and conventional bonds. We assume, based on previous studies, that there is a negative green bond premium. We are creating synthetic conventional bonds from two conventional bonds that are close the green bond in sense of characteristics. We are using the matching method to build the synthetic bond with some slight adjustments due to data limitations. Our results state that there is a positive 1.7 basis point green bond premium.

KEYWORDS: ESG, green bonds, green bond premium, SRI

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TIIVISTELMÄ:

Tutkielma keskittyy tuottoerojen tarkasteluun vihreiden ja tavallisten joukkovelkakirjojen välillä. Oletamme aiempien tutkimusten nojalla, että tuloksena on negatiivinen vihreiden joukkovelkakirjojen preemio. Luomme synteettisen joukkovelkakirjan kahdesta tavallisesta joukkovelkakirjasta, jotka ovat lähellä ominaisuuksiltaan niitä vastaavaa vihreää joukkovelkakirjaa. Käytämme 'matching methodia' rakentaaksemme synteettisen joukkovelkakirjan pienillä säädöillä johtuen dataa koskevista rajoituksista. Tulokseksi saamme 1.7 korkopisteen suuruisen vihreän joukkovelkakirjan positiivisen preemion.

AVAINSANAT: ESG, vihreät joukkovelkakirjat, vihreä joukkovelkakirja preemio, SRI

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Abbreviations

CBI	Climate Bonds Initiative
CSP	Corporate Social Performance
EIB	European Investment Bank
ESG	Environmental, Social and Corporate Governance
EU HLEG	European Union High-Level Group on Sustainable Finance
GBP	Green Bond Principles
ICMA	International Capital Market Association
OECD	Organization for Economic Co-operation and Development
PSM	Propensity Score Matching
SRI	Socially Responsible Investing

1 Introduction

1.1 Background

As Climate Bonds Initiative (2018) (hereinafter "CBI") states green bonds (referred also climate bonds) are issued to finance climate change solutions. Green bonds are a rather new security in the market, first green bond was issued in 2007 by the European Investment Bank (EIB). Green bonds can be issued by governments, banks, local government or corporations. Private placement, securitization, covered bond, and sukuk and green loans can be labeled as a green bond if they fulfill the Green Bond Principles (GBP) or the Green Loan Principles (Climate Bonds Initiative (2018)). International Capital Market Association (2018) has defined the green bonds in a following way: "Any type of bond instrument where the proceeds will be exclusively applied to finance or re-finance, in part or in full, new and/or existing eligible Green Projects and which are aligned with the four core components of the Green Bond Principles (GBP)". The aforementioned four core components are:

1. Use of proceeds,
2. Process for Project Evaluation and Selection,
3. Management of Proceeds, and
4. Reporting.

As International Capital Markets Association (2018) describes "the cornerstone of a green bond is the utilization of the proceeds of the bond for green projects, which should be appropriately described in the legal documentation for the security. Projects can be stated to be green, if they advance environmental objectives, such as climate change mitigation, adaptation, pollution prevention and control. Issuer should also communicate clearly the sustainability objectives, the net proceeds of the green bond should be trackable by the issuer in an appropriate manner, and attested to by the issuer in a formal internal process linked to the issuer's lending and investment operations for green projects. Issuers should make, and keep, readily available up to

date information on the use of proceeds to be renewed annually until full allocation, and on a timely basis in case of material developments."

Organization for Economic Co-operation and Development (2017) (hereinafter "OECD") note that parties agreed in the Paris Agreement to hold the global average temperature to below 2°C and make efforts to limit the temperature increase to 1.5°C above pre-industrial levels. The parties also agree to align financial flows with the path towards low greenhouse gas emissions and climate-resilient development.

Debt finances the most of infrastructure investment. Bond finance is a natural fit for low-carbon and climate-resilient infrastructure assets; renewable energy infrastructure, where the upfront capital costs are high and long-dated. Annual issuance of green bonds rose from 3 billion USD in 2011 to 95 billion USD in 2016 (OECD (2017)). As earlier stated, there are the GBP and many other green bond definitions but there is no universal rules and standardization; this is a shared concern among the participants in the market (OECD (2017)). With generally accepted definitions the effectiveness, efficiency and integrity of the market would increase.

Green bonds have some benefits in green investing: 1) they add one segment more to green financing; 2) they add long-term financing by addressing maturity mismatches; 3) they add the positive reputation of issuers and clarify issuers' environmental strategy; 4) they can offer cost advantages; 5) they add greenness to traditionally brown segments; and 6) they add one segment more to responsible and long-term investors (OECD (2017)).

Why to issue green bonds because the companies could also issue conventional bonds? Green bonds have to be used to green projects and this itself restricts companies' investment practices. If the bond is labeled to be a green bond it should be certified by a third-party and this adds compliance and administrative costs. Companies could issue conventional bonds and to invest the proceeds to green projects if they would be

financially beneficial (Flammer (2018)). Flammer (2018) represents three different potential explanations why to issue green bonds. "First is that green bond may serve as a credible signal of the company's commitment towards the environment (*signaling argument*). Signal can be valuable because investors do not have enough information of the company's environmental commitment. Second argument is that the companies can practice green washing with green bonds. The companies could issue green bonds even if they would not perform any real actions (*greenwashing argument*). The third argument is that if green bond investors are willing to change financial returns for societal benefits, companies are more willing to issue green bonds because they will get cheaper financing (*cost of capital argument*)." Flammer (2018) states that the evidence speaks on behalf of the first argument.

Hyun et al. (2019) note that green bonds are built in a same way as conventional bonds, but green bonds are specially used for green projects that are environmentally friendly. This means that costs are bigger when they are issued. The green bond market is still very small in size and also in liquidity. The market structure and standards that are accepted generally are still being created. There is for example documents, which show that the bonds are green, guarantees and also letter of comforts in order to show the greenness. These kind of actions of course create additional costs for green bond issuers. After the issuance the costs are still rather high because green bond issuers have to create regular reports. These costs can be significant to small and medium-sized issuers. However, green bonds also help issuers to improve their reputation and expand their investor base.

As Zerbib (2019) states a report from the European Commission (2016) emphasizes many barriers to the development of the green bond market; there is no green bond definition, framework, and transparency. Because of the aforementioned reasons, the EU High-Level Group on Sustainable Finance (EU HLEG (2018)) make many recommendations regarding the green bond market in 2018. The creation of a technical committee responsible for building a sustainable taxonomy and a

introduction of an official European standard for green bonds contributing an overt meaning of these bonds and based on the common taxonomy.

International Capital Market Association (2017) states that there are four different data providers that cite green bonds that are issued. Zerbib (2019) mentions that Bloomberg and Climate Bond Initiative strictly require that cited bond have to be aligned with the GBP. For example Zerbit (2019) and Flammer (2018) use the Bloomberg database.

1.2 Purpose of the study

The purpose of the thesis is find is there a difference between the yields between a green bond and an otherwise identical conventional bond and how much is this possible difference in the Nordics. I call the aforementioned difference: *the green bond premium* as Zerbib (2019).

The contribution of this thesis is that green bonds are still rather new security in the market and even if there is already different articles regarding the green bonds the topic is still rather new and untouched compared to some other finance topics. There is some articles regarding the green bond premium but not specially handling the Nordics. The current articles about the green bond premium have found opposite findings and some have found the premium but some have stated that there is no premium.

Zerbib (2019) and Baker et al. (2018) handle the pricing and is there a discount while trading green bonds compared to normal bonds. Zerbib (2019) find a negative green bond premium of 2 basis points, Baker et al. (2018) find a green premium of 6 basis points and Karpf and Mandel (2018) find a discount in green bonds; they find a positive yield differential of 8 basis points. However Larcker and Watts (2020) note that the past studies have ended up in mixed results because they have made methodological design misspecifications that end up in biased estimates. They state for example that Karpf and Mandel (2018) use taxable and non-taxable securities and this have caused that the results indicate the green bond premium. Larcker and Watts (2020) instead use

matching methodology while trying to seek whether there is a green bond premium or not; they seek a quasi-matching normal bond from the same issuer and examine the possible green bond premium in this way. They have stated that the green bond premium is zero.

1.3 Research question and hypotheses

My research question is whether or not there is a difference between the yields between a green bond and an otherwise identical conventional bond and how much is this possible difference in the Nordics. The null hypothesis (H0) states that there is no green bond premium. The alternative hypothesis (H_1) states that there is a green bond premium.

1.4 Structure of the thesis

This research is structured in a following way. The second section goes through the existing literature about the topic. The third section goes through the data, fourth section is about methodology, fifth is about results, sixth is about conclusions.

2 Literature review

2.1 Corporate social performance

In general corporate social performance (CSP) has been studied by many and good environmental performance has an effect on stock returners of companies (Kempf and Osthoff (2007), Semenova and Hassel (2013)). It is widely stated that CSP has a positive effect on financial performance of companies. CSP has an effect on cost of equity capital; when the CSP is high of the company (Dhaliwal et al. (2011)) and a low environmental effect take an advantage of the low cost of equity capital (Chava (2014)). Zerbib (2019) states that there are problems when transferring these findings to the debt market. The first reason is that the payoff profile of a debt holder differs from that of a stockholder reported that a bond payoff can be replicated by the purchase of a stock and the sale of a call option of the same asset. Because bondholders have upside available, it is important to analyze and assess all the downside risks for example environmental accidents. It is more important for investing that is socially responsible to insure against a market downturn and when a company acts socially responsible manner the credit rating increases and it has a strong effect on default risk decrease of a company. The second reason is that companies are affected by the bond market investors because companies are seeking financing via the debt market more frequently than they increase their capital.

Zerbib (2019) notes that studies have been made about CSP's effect on corporate bond yield, no consensus have been found. Magnanelli and Izzo (2017) state that CSP has an negative effect on cost of debt; it increases the cost of debt. Their theory states that if a company uses its resources to CSP it is a waste of valuable resources and it has an effect on company's performance. Menz (2010) states that on the European corporate bond market socially responsible companies gain negative impact on large credit spread on the contrary than non-socially responsible firms. Oikonomou et al. (2014) state that good CSR performance enables lower bond yields and CSR irresponsibility is correlated in a positive way with financial risk for U.S. corporate debt. Hasan et al.

(2017) note that companies that are in U.S. and, which have high level of social capital gain benefit from low at-issue bond spreads. Goss and Roberts (2011) research how the CSR scores of U.S. companies impact on the price of the bank loand of the firms. They have noted that firms with lowest CSR scores have to pay the highest prices of the bank loans; 7 to 18 basis points more than the more responsible ones. Klock et al. (2005) state that when comparing companies with strong shareholder rights and companies with strong management rights they have a 34 basis point lower cost of debt. Ge and Liu (2015) have stated that new corporate bonds, which are issued in the U.S. primary market and when companies have positive reports in CSP the spreads of the bonds are smaller.

2.2 Green bond premium

Zerbib (2019) states that the green bond yield is not based on the CSP of the issuing company because the green bond label is only used with the funded projects and not with the issuer type. This is the reason why a green bond yield can be compared to similar conventional bonds. Ehlers and Packer (2017) and CBI (2018) study the difference between a green bond and a conventional bond and they have compared the differences in the yields of the bonds. CBI (2018) do not find differences that were significant on the primary market and this states that the inverstors are not eager to pay premium to get a green bond at issuance. Ehlers and Packer (2017) find a -18 basis points negative premium at issuance in 2014 - 2017 on 21 Euro- and USD-demoninated bonds. Barclays (2015) and Bloomberg (2017) examine a yield difference on the secondary market. Barclays (2015) examines credit spread on market risk factors by using the OLS regression and by using this they report a negative premium of 17 basis points between March 2014 and August 2015. Bloomberg (2017) instead reports a negative premium of 25 basis points by examining twelve Euro-denominated government-related bonds but it doesn't report premium on USD-denominated and corporate bonds bonds between March 2014 and December 2016.

Various authors have researched green bond premium. Karpf and Mandel (2018) research the topic. They concentrate on the US municipal bond market; they investigate whether or not investors value green bonds differently from conventional bonds. They use a sample of 1880 bonds but the sample does not meet the strict limitations of the Green Bond Principles and they report a positive 7.8 basis points average yield premium on green bonds between 2010 and 2016; however premium is negative since 2015. Karpf and Mandel (2018) note that when green bonds offer a premium; the premium is reflected in share price also. Karpf and Mandel (2018) also note that green bonds have a lower cost of capital to issuers compared to conventional bonds. Differences in return rates can be covered by issuer characteristics. The fact that green bonds are green is not itself explaining the difference.

Karpf and Mandel (2018) get support to this statement from Tang and Zhang (2018). Tang and Zhang (2018) state that a yield spreads of green bonds and conventional bonds, that are issued by commercial entities, compared to firms that have issued conventional bonds, green bonds have benefits in pricing for their issuers. When the same firms issues green bonds and conventional bonds there are no pricing benefits. Tang and Zhang (2018) have however only 41 observations so it quite unreliable and it is dangerous to make strong conclusions based on that. Barclays (2015) and Karpf and Mandel (2018) suggest that the liquidity premium should be controlled by using the a time variable in the regression because the emission for the previous article and a variable equal to the number of transactions within the past 30 days for the latter.

Zerbib (2019) states that the current researches on the relative valuation of green bonds are lacking of a limited of analysis and incomplete control of the liquidity premium. Zerbib (2019) states that his research contributes to the current literature in a following way; he is going to "carry out an extensive analysis of the green bond premium by using a global database and at the same time controls the liquidity and maturity biases". Zerbib (2019) states also that they show that the small negative yield premium is a result from an excess of demand of green bonds compared to

conventional bonds and this theory is suitable at least to investment-grade, low-rated bonds and financial bonds. Zerbib (2019) states that "the results complement the literature on the relationship between CSR and bond yield by highlighting the existence of a premium linked to the preference for an asset dedicated to funding sustainable development, independent of the issuer's CSP."

Larcker and Watts (2020) state that it is not nontraditional theoretical idea that investors can value securities above their expected risk and return features. They note also that it is difficult to separate the effect in real market settings. Martin and Moser (2016) and Riedl and Smeets (2017) try to find out the aforementioned preferences from experimental or survey data. Barber et al. (2020) use expected returns and risk from actualized returns and security characteristics. Larcker and Watts (2020) state that it is still unclear whether investors are ready to abstain financial benefits in real market, if risk and return are known beforehand. Larcker and Watts (2020) state that green bonds are very good way to explore the matter. They function same way as the standard debt securities issued by municipalities and corporations.

Larcker and Watts (2020) are interested to find whether or not the investors in bond markets are ready to give up returns to invest in environmentally sustainable assets. Larcker and Watts (2020) concentrate on the municipal green bond market because it "offers a nearly ideal setting to explore this research question." By investing the municipal bonds Larcker and Watts (2020) can use various one of a kind institutional characteristics of municipal markets. One of these is that municipal issuers often issue otherwise identical green and non-green municipal securities at the same time. They are identical to ordinary municipal bonds expect they are used to finance one or more environmentally friend projects. This enables usage of a model-free matching method to appraise treatment effects. Yields, spreads and other bond characteristics can be compared between almost identical securities from the same issuer and on the same issue date. Larcker and Watts (2020) state also that another useful property is that the mediocre issuance size of the municipal bonds is about 5 million dollars. The average

issuance size of corporate bonds in the United States in the same time period is about 400 million dollars. Green issues are thus rather small and this allows smaller traders also invest when the green issues are large it restrains smaller traders out of the offerings. Larcker and Watts (2020) note that "investors with utility for green investments and the willingness to trade off bond yield for green use of funds are likely to be marginal trader setting the price of the bond." For these reasons Larcker and Watts (2020) state that their style is a good way to find greenium if it exists.

2.3 Mixed results of the green bond premium

Quite many of the studies provide appraisal for greenium, but the results are impure. Karpf and Mandel (2018), Baker et al. (2018) and Larcker and Watts (2020) are mostly related to one another. Each of the studies use rather large sample of issued green bonds in the municipal market. Larcker and Watts (2020) have the biggest sample and Karpf and Mandel (2018) and Baker et al. (2018) sample is about 60 % of the Larcker and Watts (2020) sample. Karpf and Mandel (2018) find positive yield differential; green bond discount, which is about eight basis points. Baker et al. (2018) find a green bond premium of six basis points. The findings are discrepant compared to industry practitioners views. Chiang (2017) states that people who answered by the State Treasures Office of California stated that "their firms would not accept a lower yield for a green bond."

Larcker and Watts (2020) believe that the inconsistent results of the earlier studies is a consequence of "methodological design misspecifications that produce biased estimates" and as stated already earlier Zerbib (2019) states that the current researches on the relative valuation of green bonds are lacking of a limited of analysis and incomplete control of the liquidity premium. Larcker and Watts (2020) note that Baker et al. (2018) and Karpf and Mandel (2018) compare taxable and non-taxable securities; thus they ignore the effect of taxation in the municipal securities market. Baker et al. (2018) use a pooled fixed-effects model in their analyses. Larcker and Watts (2020) state that this is insufficient to "successfully control for nonlinearities and

issuer-specific time variation, which ultimately leads to spurious inferences." Larcker and Watts (2020) state that they avoid this by "taking advantage of the unique institutional features of the municipal securities market". This enables optional security.

Larcker and Watts (2020) find a small differential between green and conventional bonds. They state that "this pattern is robust to perceived differences in liquidity or institutional ownership." They state also that greenwashing by issuers is improbable to be responsible for their findings. Larcker and Watts (2020) state also that municipal investors in the USA are not eager to offer up returns to invest in green bonds. Green bonds are only a small share of the debt market. The reason for this is the high issuance cost according Larcker and Watts (2020) and Chiang (2017). Larcker and Watts (2020) state that only benefit in the green bonds is that they diversify the investor base of the issuer and this result is consistent with the practitioners' views (Braun (2019)). Larcker and Watts (2020) note that municipal securities market is institutionally different compared to other asset classes.

For example in the corporate green bond market there might be premium in green bonds but Larcker and Watts (2020) see that it is however unlikely; the premium should appear in the municipal green bonds most likely. The second reason is that the sample size of Larcker and Watts (2020) is rather small and it is likely that green investors are the marginal trader for pricing the asset. This is the reason why the municipal green bond pricing should reveal if the small traders of green bonds are the marginal investors for pricing the asset. Thus, municipal green bond pricing ought uncover if the green bond marginal trader is consenting to pay a premium for a bond that is used to finance environmentally friendly scheme.

Zerbib (2019) states that green bonds are engaging financial instruments that advance the environmental change and at the same time they are making possible for low-carbon project possessors to spread out their funding ability. Zerbib (2019) compared the yield of a green bond compared to equal synthetic conventional bond via a matching method. By green bond premium Zerbib (2019) means the yield difference between the green bond and the conventional bond and before this controlling the difference in liquidity. As said earlier, Zerbib (2019) finds small but pregnantly negative and equal to -2 basis points in the whole sample. The negative premium is bigger for financial bonds and low-rated investment-grade bonds. Zerbib (2019) states that the study has many implications. Investors and issuers can use the method for pricing the recently issued green bond fixed points. It also shows that there is a lack of green bonds conditional to the investment demand in many market segments and calls for operative and fiscal measures to increase the administration of green bonds issued. The investors at the moment can soak up a yield at issuance; it is a bit lower than indicated by the conventional curve.

Zerbib (2019) notes that the methodology that he has used is being used also with the European Investment Bank green bonds while investing the existence of the green bond premium. The results note that there is a -8 basis points negative premium since January 2017 for the four main green bonds issued. Zerbib (2019) notes that the quality of the data may cause inaccuracy to the results and the fair value can be biased. Zerbib (2019) state that following researches should focus on understanding the determinants of the green bond premium via a market microstructure theoretical model. Second idea that Zerbib (2019) introduces is "designing public supporting measures, assessing their effects on the green bond market's microstructure, and comparing the differential impacts via sensitivity scenarios." Third idea is that Zerbib's (2019) study could be expanded to another kind of bonds for example to social impact bonds.

Hyun et al. (2019) examine if the information about greenness has an effect on the green bond market prices. Hyun et al. (2019) use liquidity-adjusted yield premiums of green bonds and compare these to synthetic conventional bonds. They find no relevant premium from green bonds or reduction that is strong to distinct estimation procedures. Instead, they find strong proof that information of the greenness indicators pregnantly effect on the level of the green bond premium. Green bond with CBI certificate get 6 basis points and 15 basis points reduction compared to green bonds that do not have that kind of information. The aforementioned reduction can essentially compensate for the supplementary expense of these information enhancers. When the green bond market develops, the information enhancers may take action to decrease the expense of obtaining independent reviews and verification. Hyun et al. (2019) state that the issue size can decrease the green bond premium and that there is a green bond premium.

Hyun et al. (2019) state also that green bonds are naturally good way to finance green projects but they could be developed further, in connection with market structure and arrangement. In the eyes of the supply side it is expensive to issue green bonds comparared to conventional bonds. In the eyes of the demand side, the investors meet information asymmetry about greenness in relation of issuers. Green bond standard and guideline decrease heterogeneity and segmentation of worldwide green bond markets. Issuers can reduce their financing expenses and investors can benefit of lower greenness information costs if the information enhances. Hyun et al. (2019) state that by investing to green investments should not lead to lower returns. Certain green bonds offer smaller returns but at the same time they offer lower information costs. In order to tempt institutional investors to invest to green bonds, issuers should monetise environmental externalities and positive impacts. This might stimulate institutional investors to add green bonds in to their investment palette and asset targeting.

Febi et al. (2018) note that there is a yield spread in green bonds, which is -5 to -30 basis points smaller than in conventional bonds. This yield spread premium is however

changed to trivial in the recent years, this can mean that green bond market is maturing. As Larcker and Watts (2020) state the green bond premium that different researchers have found can be a result from the higher bond liquidity compared to conventional bonds and not all the researchers have controlled this effect in their studies. Febi at al. (2018) study the determinant power of bid-ask spread. Whether the ask price surpass the bid price and LOT liquidity measure, which measure the difference between the percent of buying cost and the percent of selling costs and yield spread between conventional bonds and green bonds. They state that conventional bonds are less liquid that green bonds because of bid-ask spread an LOT liquidity measure. Febi et al. (2018) like Zerbib (2019) state that bid-ask spread is unmeaning determinant for green bond returns but it is meaningful determinant for conventional bonds. Febi et al. (2018) state that LOT measure is a admissible determinant for green bond yields but at the same time it is a trivial determinant for conventional bonds.

Febi et al. (2018) state that green bonds seem to face higher liquidity levels in the market and this is a strong event in the market. Now and also in the future, investors will face pressure to point out ESG and SRI entrustment. This will head to imposition exceed over to provision. The provision will probably remain low because of fiscal stimulus for investments (Zerbib (2019)) state that and inexistence of an official and global disposal (Cochu et al. (2016)) of course GBP is trying to patch this up. This means that better liquidity of green bonds does not come from environmental enhancements but from deficiency of supply and this makes it possible green bond premiums (Zerbib 2019). Cochu et al. (2016) state that also the inexistence of credit risk profile concerning unfit reporting of green projects can prove the illiquidity of green bonds compared to conventional bonds. Cochu et al. (2016) note that the ratings of green bonds are concentrated to balance sheets in place of green project investments. This means that green bonds can be directed to riskier investments compared to conventional bonds and this should mean actually a negative green bond premium. Higher risk level gets a support from bond maturity and yield relation. Campbell and Taksler (2003) state that investment grade bonds are very likely to have a positive

linkage among maturity and yield spreads. The most of the green bonds are investment grade bonds and hence the results should be equivalent. Febi et al. (2018) note however that the results is reciprocal between the aforementioned factors; normally this result is expected for speculative-grade bonds. Karpf and Mandel (2018) found the same appearance in their study; there is reversed relationship between the aforementioned factors for bonds when the years to maturity are under three years.

Gianfrate and Peri (2019) use a propensity score matching approach to study 121 European green bonds issued between 2013 and 2017. They state that green bonds are financially more convenient than conventional bonds. For corporate issuers the benefit is larger and it remain in the secondary market. Gianfrate and Peri (2019) state that their findings keep up the view that green bonds can help in greening the finance without penalizing the issuers. Stellner et al. (2015) note that superior corporate social performance (CSP) leads in systematically reduced credit risk but the evidence is however weak. Menz (2010) note that in European corporate bond market the premium in the risk for socially responsible firms is higher than for non-socially responsible firms the finding is slightly significant. Gianfrate and Peri (2019) state also like many other that the results concerning the green premium is mixed in the primary market and also in the secondary market.

Gianfrate and Peri (2019) note that their research extend the existing literature concerning the green bonds by providing evidence of the existence of a significant advantage for the primary market of European green bonds adopting a propensity score matching (PSM) methodology. They note also that the premium stays after the issuance; in the secondary market. Gianfrate and Peri (2019) use also Bloomberg's data from "Bond radar "as many other researchers. They use bonds issued from January 2007 to December 2017. In the bond radar there is 7589 public eurodenominated bonds issued since January 2007 and 154 of these are green bonds. They do not use bonds that have variable interest payments because this can affect on the pricing at issuance. They do not use also bonds that are missing the returns or if the size is lower

than 200 million euros, this enables that the bonds are liquid. They also do not use bonds at high risk of default and bonds that are not priced using European rates. Using the aforementioned parameters, there are 121 green bonds left in the data and there are different entities such as corporates, national and multinational agencies, municipalities, sovereign states and financial institutions. They divide the sample to two different samples: "Corporate Issuers" and "Non-corporate Issuers". 43 of the observations concerning the Corporate Issuers are labeled green and 78 of the Non-Corporate Issuers are labeled to be green.

Gianfrate and Peri (2019) evaluate whether it is convenient of issuing green bonds for companies and to non-corporate entities that want to invest in green projects like in energy and water efficiency and bioenergy. They state that green bonds are more favourable than conventional bonds because normally they offer lower returns for the financiers. Gianfrate and Peri (2019) note that the "result is stronger for corporate issuers with the implication that private sector - whose support will be necessary to achieve the Paris Agreement's temperature goal - are better off financially when they issue bonds that are labelled as green."

Green bonds have transaction costs because they have to be certified, monitor and report on the green use of progresses. Gianfrate and Peri (2019) state that financial savings that issuers get seems to be a result of a strong demand for these financial products and this means that there is willingness to invest in green projects. Institutional financiers want to decorbanise their portfolios and redirect their assets to environment-friendly investments because climate change is also a increasing threat to the economic growth in a long perspective. The law also effects on the institutional investors because for example in France investors have to report on how they reduce CO_2 releases and what they do to control climate related risks. In future countries can for example offer tax benefits for investors that invest in green products for to help to improve the market. It can be waited that there is coming new green bond issues because of the adoption of a common European Union green asset taxonomy

(European Commission (2018)). Banks will probably start to implement the reporting recommendations that are set forth by the Taskforce for Climate related Financial Disclosure (TFCD (2017)). Monetary policies will probably also favour investments that are made in green-labelled assets. Issuers will get better financial results with green bonds and also the financial results are better. The global economy also turn into more sustainable and it can also enable investors to comply with the current and coming legislation.

Gianfrate and Peri (2019) have a rather small data sample and the sample should be bigger and also the geographical region should be wider. When the quantity and quality of data will be better, it is relevant to do further research in the eyes of the issuers, investors and policymakers. Researches in the future should contain information whether or not green bonds' amenity has objectively changed in the course of time and has there been variation over industries and regions. Secondly, by analyzing better and understanding the formation of the demand of these bonds and its drivers, the policies can be designed to proceed with and foster the growth of the market. Gianfrate and Peri (2019) note also that the green label should be studied more closely. The bonds can suffer from that there is now clear definition what is a green bond and what is not. In order to create a reliable and consistent criteria for the bonds demand both scientific analysis and political and standard-setting decisions. A formal taxonomy is trying to be created by the European Commission and with this action the misuse of the green bond label can be avoided.

Gianfrate and Peri (2019) note that global warming can be restricted to 1.5°C but this require changes in the economic and social systems. Gianfrate and Peri (2019) state that "Financial markets will play a major role in those disruptive changes and practitioners, policymakers, and scholars are converging in stressing how crucial the support of finance is in delivering an actual and timely transition to a low carbon economy." Gianfrate and Peri (2019) show that green bonds can be used to achieve a lower cost of capital for organizations that need to finance or re-finance green projects.

Gianfrate and Peri (2019) note that there is limited evidence on corporate decisions in issuing green bonds and their findings fill in the existing literature gap and companies can use the results to make decisions regarding different financial instruments. Policymakers can use it while they make policies; they recognize which policies startle or stimulate the market and issuers to pass innovative green funding instruments.

Barua and Chiesa (2019) examine what is the size of the financing that happens with green bond supply. They use cross-section OLS regressions and Blinder-Oaxaca decomposition analysis and they have a global data for 8 years (2010 - 2017) and the data is from Bloomberg. They investigate how the bond characteristics, issuer characteristics, and market characteristics effect on issue size. They test also "the persistence of the effects by year-wise and rating grade-wise estimations". They note features that had a relevant impact on issue size, "the effects of coupon rates (negative effects) and credit rating (positive effects) on issue size is permanent in nature as they consistently persist over the years and across rating grades". Concerning "the issuer-specific, revenue growth (mostly negative effects) and profitability (positive effects) have relatively more persistence across the estimations". Issue sizes are larger in emerging markets of the market and economy variables. Also the issuances that are in EURO and targeted to global market have most likely a bigger issue size, and the impact is most persist across assessments. Issue size is likely to be smaller when the issuance is targeted to international market.

Barua and Chiesa (2019) note that their research confirm the aforementioned effects of the abovementioned factors, especially for high-grade bonds. They note that they have not found evidence of a notable increase of average issue size in 2017 compared to 2016. This can mean that environmentally responsible and sustainable business projects have not been undertaken more by the companies. High-grade bonds on average get less finance per issue compared to other bonds. Barua and Chiesa (2019) state that their finding have important policy implications. First, for example "better financial health (e.g., profitability) and higher quality of the security (e.g., rating) would

enable firms to finance a larger amount, which should be considered by the policymakers and relevant agencies when encouraging green bond issuance". Second, policymakers could target to pledge emerging markets more to increase financing size. Third, EURO denominated bonds are rather popular but issuances of larger USD and CNY should be increased. Fourth, issuance per issue on average is not increasing although the aggregate green bond market has broaden fast. In the future, policy efforts should pay more attention to "per issue size of financing" and there should be countenance to finance more per issue. Companies could for example move from traditional finance to green bonds. Barua and Chiesa (2019) note that " although most of the existing green bond have an investment grade rating, high grade bonds show a relatively low size of financing compared with the others. To ensure that the green market expands properly and mobilizes even a greater finance towards environmentally responsible investments, we need to ensure that the size of financing by firms consistently increases over time, particularly by higher quality green bonds issuance".

3 Data and methodology

3.1 Data

Data for the research is combined from two sources. A data concerning the green bond issuers is retrieved from Danske Bank and from their data we were able to collect ISINs of green bonds and based on these ISINs the University of Vaasa was able to collect bid and ask prices of the green bonds and also the yield data. Because we needed also two matching conventional bonds towards a green bond the University of Vaasa delivered conventional bond data from the same issuers as the green bonds and after this we had to go through a thousand of conventional bonds to find the matching conventional bonds as described later on the study. There is no certainty where Danske Bank get their data but it can be gathered Bloomberg's database but there is no full certainty of this. The data contained everything else of the green bonds but not the bid and ask prices. The University of Vaasa provided the price data based on the data that Danske Bank delivered. The University of Vaasa researched the price data from Datastream. Danske Bank's data contains 531 green bonds when limiting it to concern only the Nordics.

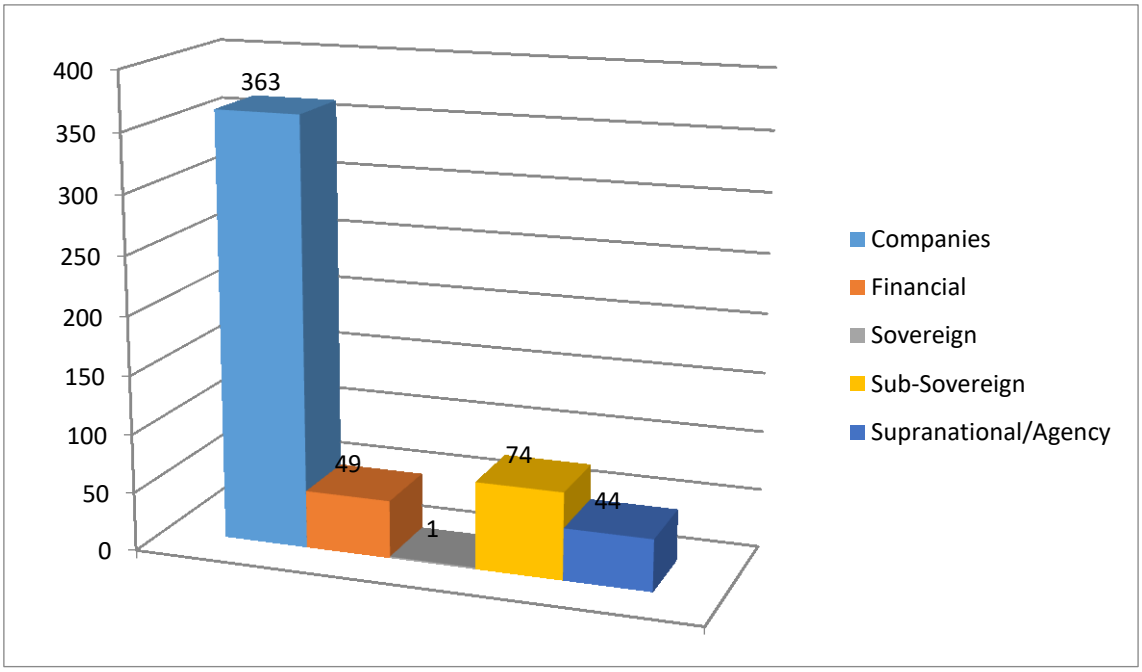


Figure 1. Distribution of the green bonds by issuer type in the Nordics. Adapted from Danske Bank's data.

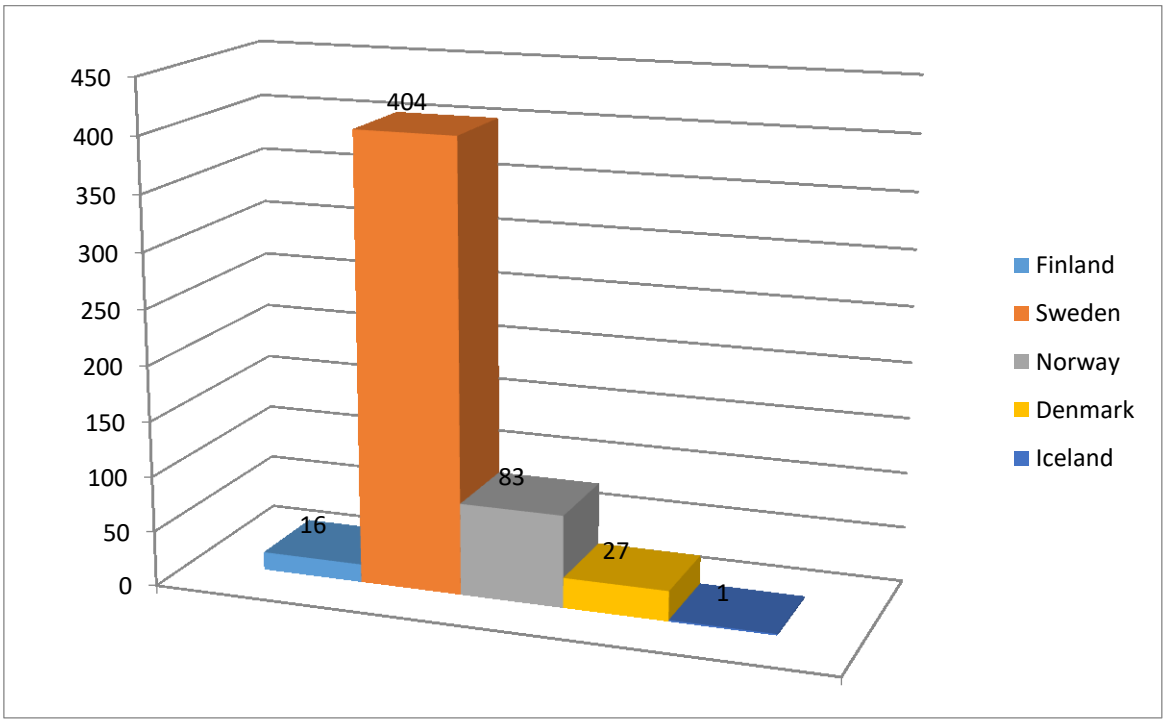


Figure 2. Amount of issued green bonds by 6/2020. Adapted from Danske Bank's data.

3.2 Methods

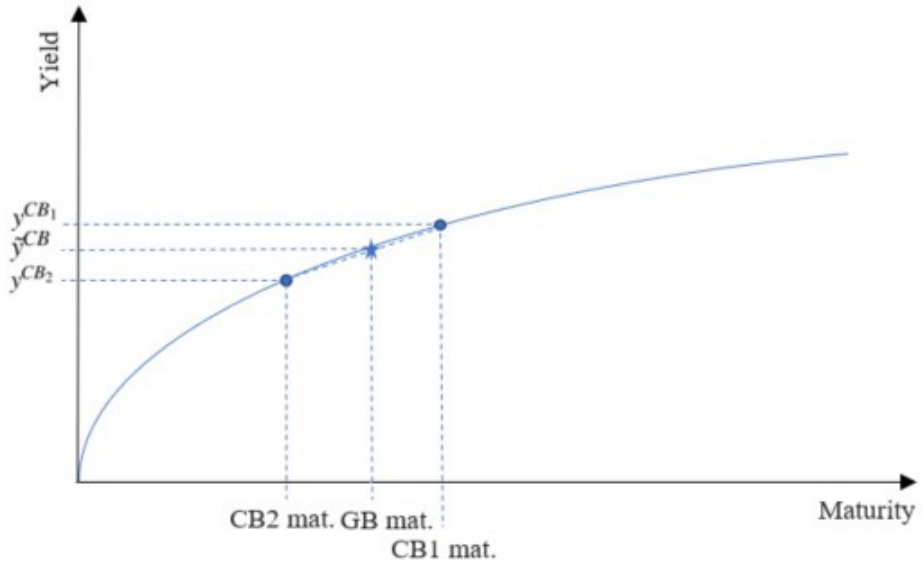
Studies that concern CSR and are analyzing bond spreads use a regression on a appropriate definition as a empirical method. This requires that financial and extra-financial independent variables are defined and they are used to define endogenous value of the bond spread as comprehensively as possible while making sure that the specification is robust (Zerbib (2019)). The aforementioned style can be used also in this research. We can match two similar bonds from the same issuer. Zerbib (2019) notes that the most of the factors that are affecting to the yield are identical. This enables usage of a matching method. This method can be used to analyze the endogenous value of a specialized financial instrument. When using the method a pair of securities with the same qualities except for the one property whose impact we are interested in. Helwege et al. (2014) use for example the method to match and compare pairs of bonds issued by the same firm in order to research the cost of liquidity.

The same method is being used as Zerbib (2019) and making a database in order to evaluate the yield spread between a green bond and a similar synthetic conventional bond. We need a matched pair that contains a green bond and a conventional bond with similar characteristics except the liquidity. We are doing the same as Zerbib (2019) and adding a new parameter, which is the greenness of a bond. We want to know how this parameter affects on the bond yield. The green bond yield and the equivalent synthetic conventional bond yield is thus the cumulative effect of the liquidity differential and the green bond premium.

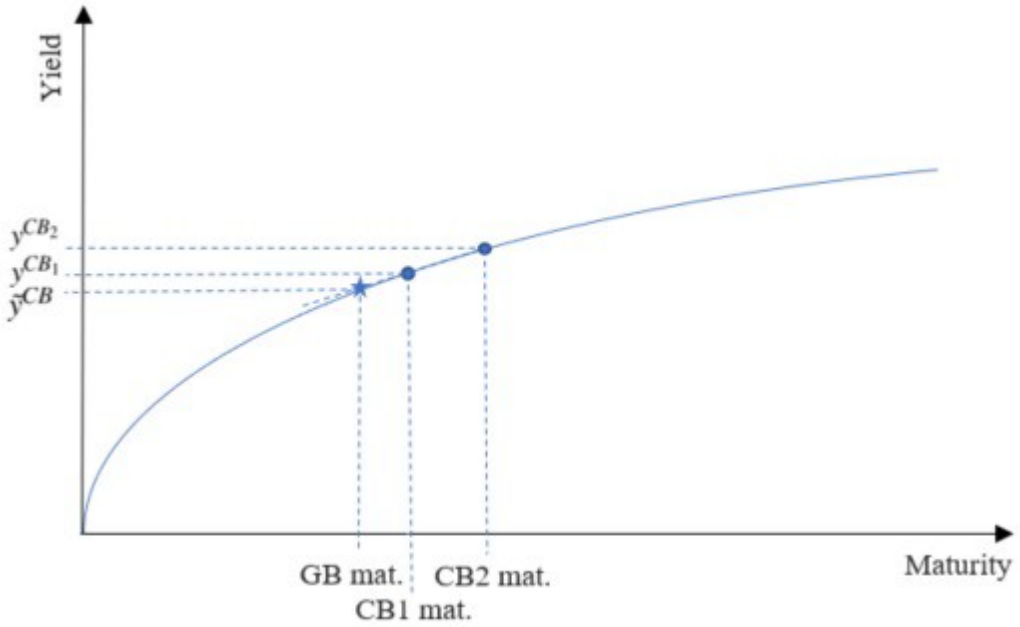
The data includes different kind of bonds: corporate, financial, sovereign, sub-sovereign / municipality and supranational / agency. We have to create a synthetic bond for every green bond. This demands that we have a two conventional bonds with a quite close maturity from the same issuer and the other characteristics should be the same such as: currency, rating, bond structure, seniority, collateral and coupon type. The maturities are not equal but they should be rather close to the green bond, thus we are using the same method as Zerbib (2019) and collecting conventional bonds that

have a maturity that is neither two years shorter nor two years longer than green bond's maturity. By doing this we are able to estimate more precisely the corresponding synthetic conventional bond yield in the next step. Zerbib (2019) notes that the difference in bonds liquidity is other difference between these two group of bonds. The difference can be estimated by the issue amount or the issue date as Houweling et al. (2005) for example note. If there is a notable difference in liquidity it can have a big difference on the yield level and this is the reason why it has to be limited. We have to restrain the suitable conventional bonds to those as Zerbib (2019) has noted "(i) with an issue amount of less than four times the green bond's issue amount and greater than one-quarter of this amount and (ii) with an issue date that is, at most, six years earlier or six years later than the green bond's issue date." By using this double restriction as Zerbib (2019) notes we are able to control better residual liquidity bias in the estimation step of the green bond premium. By doing the aforementioned limits to our data, we have 64 green bonds.

Maturity bias is the next thing that we want to eliminate and this happens by forming a panel composed of pairs of bonds as Zerbib (2019) notes. The yields are retrieved for the green bond and the matching two conventional bonds from the issue date of the green bond up to December 31, 2020. Ask yields of the aforementioned three bonds are under more close examination because we want to observe investors' demand and issuers' supply of green bonds. Zerbib (2019) limits its data also by removing the line from their panel if on a specific day, at least one of the three ask yields is not available. We are not able to do the same due to lack of data we have to modify Zerbib's model and we have to include also bonds that do not have a data on a specific date. This can cause some bias to the results. Zerbib (2019) interpolates or extrapolate the two conventional bonds' yields linearly at the green bond maturity date to obtain a synthetic conventional bond yield. Thus, the synthetic conventional bond has the same properties as the green bond except the difference in liquidity.



(a) interpolation



(b) extrapolation

Figure 3. "Interpolation and extrapolation of the synthetic conventional bond yield. This figure shows how we calculate the yield of the synthetic conventional bond through (a) a linear interpolation or (b) a linear extrapolation of the yields of CB1 and CB2 at the maturity date of the green bond." Zerbib (2019).

Our problem is the limited data and thus we are not able to create synthetic bond yield data with the interpolation or with the extrapolation. Because of this reason we are taking the distance-weighted average of CB1's and CB2's yields and forming ask yield of

the synthetic bond $n^{\sim CB}$ and taking the yield difference of the green bond and the synthetic bond ($\Delta\tilde{n}_{i,t}$). We can see from the table 1 that maturities are rather close to each other and yields are a bit larger among the conventional bonds compared to the green bonds. Issue amounts seem to be a bit higher among green bonds. Some of the green bonds were lacking of yield data and we are left with 57 green bonds after searching the yield data.

Kapraun et al. (2019) have compared also the issue yield difference and our issue yield difference of the green bond and the CB1 and CB2 is -3,74 basis points and the difference of the green bond and the CB1 and CB2 median is -4,2 basis points. Yield difference is 1,4 basis points and median is 7,2 basis points when we are comparing the green bond with the synthetic bond that we formed with the distance-weighted average of CB1's and CB2's yields. We are using the latter results / data in our further tests.

	Min	Median	Mean	Max
Issue yield of the GB	-0,3950	0,2940	0,4764	2,212
Issue yield of the CB1	-0,589	0,2940	0,4861	3,813
Issue yield of the CB2	-0,7810	0,3360	0,5415	3,813
Issue yield of the CB1 and CB2	-0,7810	0,3360	0,5138	3,813
Yield difference % ($\Delta\tilde{n}_{i,t}$)	-34,0929	0,7216	0,1396	30,5352
GB Coupon (%)	0,00	0,7365	0,8470	2,473
CB1 Coupon (%)	0,00	0,6570	0,7905	4,301
CB2 Coupon (%)	0,00	0,7225	0,8122	4,318
GB issue amount (EUR)	94707621,26	62442783,05	19661370,25	1000000000,00
CB1 issue amount (EUR)	78727964,3	46695754,35	9830685,13	1000000000,00
CB2 issue amount (EUR)	72874532,00	44238083,07	9830685,13	1000000000,00
GB maturity (years)	2,5	5,45	5,02	7,8
CB1 maturity (years)	2,0	5,25	4,7	8,2
CB2 maturity (years)	2,0	4,75	4,57	7,4

Table 1. Descriptive statistics of the bonds in the sample. The table summarizes the 64 green bonds and the two matching conventional bonds qualities.

4 Experimental methodology

4.1 Is there a green bond premium or a green bond discount?

We are estimating the green bond premium as Zerbib (2019) with experimental methodology by trying to control the residual difference in liquidity. For the previous purpose we need a variable $\Delta Liquidity_{i,t}$, with the variable we can find the difference in liquidity between a green bond and a conventional bond liquidity:

$$\Delta Liquidity_{i,t} = Liquidity_{i,t}^{GB} - Liquidity_{i,t}^{CB} \quad (1)$$

Thus, we can define green bond premium s_i as an unobserved effect in the fixed effect panel regression on $\Delta Liquidity_{i,t}$:

$$\Delta\tilde{n}_{i,t} = s_i + \beta\, \Delta \mathrm{Liquidity}_{i,t} + \omega_{i,t} \text{ while } \omega_{i,t} \text{ being the error term} \quad (2)$$

As Zerbib (2019) notes there are three restrictive aspects when deciding the liquidity proxies when taking into account data sources and our regression model. Our data is low-frequency data and thus we cannot use intraday liquidity indicators such as Roll and Gamma measure. Second point is that we do not have data of the daily trading volumes, which have been used as liquidity proxies. Zerbib (2019) states also that "to ensure full rank condition of a *within* regression, any variable that does not change over with a given bond is not suitable". Thus, the issue amount and the issue date cannot be used (Houweling et. al (2005)). We are using the closing percent quoted bid-ask spread like Zerbib (2019). Fong et al. (2017). Fong et al. (2017) have proved that it is the best low-frequency liquidity proxy and it is widely used as a measure of illiquidity of a bond.

As noted earlier the synthetic bonds is structured of two conventional bonds, thus the conventional bond's bid-ask spread is the distance-weighted average of CB1's and CB2's bid-ask spreads. We are using here the same method as Zerbib (2019) and $d_1 = |Green\ bond\ maturity - CB1\ maturity$ and $d_2 = |Green\ bond\ maturity - CB1\ maturity|$. We get the synthetic conventional bond's bid-ask spread with the following formula (Zerbib (2019)):

$$\mathrm{BA}_{\mathrm{i,t}}^{\mathrm{CB}} = \frac{\mathrm{d}_2}{\mathrm{d}_2 + \mathrm{d}_1} \mathrm{BA}_{\mathrm{i,t}}^{\mathrm{CB1}} + \frac{\mathrm{d}_1}{\mathrm{d}_1 + \mathrm{d}_2} \mathrm{BA}_{\mathrm{i,t}}^{\mathrm{CB2}} \quad (3)$$

$\Delta BA_{i,t} = BA_{i,t}^{GB} - BA_{i,t}^{CB}$ is thus the independent variable, which is used in equation (2) to estimate the fixed effect-linear panel. Table 2 contains data about ΔBA is approximately zero and like in Zerbib (2019) we have also a low standard deviation. This means that the issue amount and the date of issuance as the liquidity controls in the matching method ended up results that are acceptable.

	Min	**Median**	**Mean**	**Max**	**Standard de-viation**
ΔBA	-17,664 %	-0,003 %	-0,079 %	3,944 %	0,590 %

Table 2. Liquidity proxy ΔBA. ΔBA is the difference between green bonds' bid-ask spread and the conventional bonds' distance-weighted average bid-ask spread on a period of time that has been explained earlier.

We are estimating the fixed effect s_i in equation (2) for numeral reasons. We are able to control the bond-specific time-variant unobserved effect and at the same time we are not inflicting distribution or getting effect from the other bonds. The data also includes the characteristics of a specific bond (Zerbib (2019)). Zerbib (2019) notes also that "strict exogeneity holds and ensures unbiasedness and consistency of the estimator." Thirdly, we do not need "the difference in liquidity proxy to be uncorrelated

with the unobserved specific effect provides for a wide range of potential control parameters" (Zerbib (2019)).

We are running the fixed effect panel data regression and also random effect panel data regression and after the random effect panel regression running a Hausman test to see the efficiency of fixed effect estimator. The Hausman test notes that the individual effects correlate with the explanatory variable and the probability-value is statistically significant at 1 % level. Thus, we use the fixed effect estimator. We can see that there is some problem because Durbin-Watson stat is under 1. Rule of thumb is that if the Durbin-Watson is less than 2 there is positive serial correlation. Because of this we are using lagged version of the yield difference (Table 6) and we can see that the Durbin-Watson value is much better and we get rid of the serial correlation.

Dependent Variable: YIELD_DIFFERENCE
Method: Panel Least Squares
Date: 04/28/21 Time: 14:20
Sample: 11/26/2013 12/31/2020
Periods included: 1853
Cross-sections included: 57
Total panel (unbalanced) observations: 35829

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.170584	0.003288	51.88560	0.0000
DELTA_BID_ASK_SPREAD	0.441196	0.007273	60.65855	0.0000

Effects Specification

Cross-section fixed (dummy variables)

Root MSE	0.611962	R-squared	0.270914
Mean dependent var	0.135231	Adjusted R-squared	0.269752
S.D. dependent var	0.716706	S.E. of regression	0.612458
Akaike info criterion	1.858944	Sum squared resid	13417.87
Schwarz criterion	1.872682	Log likelihood	-33244.06
Hannan-Quinn criter.	1.863315	F-statistic	233.1891
Durbin-Watson stat	0.313474	Prob(F-statistic)	0.000000

Table 3. Yield difference $\Delta\tilde{n}_{i,t}$. $\Delta\tilde{n}_{i,t} = s_i + \beta\,\Delta\text{Liquidity}_{i,t} + \omega_{i,t}$ while $\omega_{i,t}$ being the error term with fixed effect panel regression.

Dependent Variable: YIELD_DIFFERENCE
Method: Panel EGLS (Cross-section random effects)
Date: 04/28/21 Time: 14:48
Sample: 11/26/2013 12/31/2020
Periods included: 1853
Cross-sections included: 57
Total panel (unbalanced) observations: 35829
Swamy and Arora estimator of component variances

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.201434	0.041616	4.840264	0.0000
DELTA_BID_ASK_SPREAD	0.437160	0.007249	60.30339	0.0000

Effects Specification	S.D.	Rho
Cross-section random	0.312640	0.2067
Idiosyncratic random	0.612458	0.7933

Weighted Statistics

Root MSE	0.612841	R-squared	0.092039
Mean dependent var	0.011014	Adjusted R-squared	0.092014
S.D. dependent var	0.643187	S.E. of regression	0.612858
Sum squared resid	13456.46	F-statistic	3631.748
Durbin-Watson stat	0.311658	Prob(F-statistic)	0.000000

Unweighted Statistics

R-squared	-0.035277	Mean dependent var	0.135231
Sum squared resid	19052.90	Durbin-Watson stat	0.220114

Table 4. Yield difference $\boldsymbol{\Delta}\tilde{n}_{i,t}$. $\boldsymbol{\Delta}\tilde{n}_{i,t} = s_i + \beta\, \boldsymbol{\Delta}\mathrm{Liquidity}_{i,t} + \omega_{i,t}$ while $\omega_{i,t}$ being the error term with random effect panel regression.

Correlated Random Effects - Hausman Test
Equation: Untitled
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	46.563734	1	0.0000

Cross-section random effects test comparisons:

Variable	Fixed	Random	Var(Diff.)	Prob.
DELTA_BID_ASK_SPREAD	0.441196	0.437160	0.000000	0.0000

Cross-section random effects test equation:
Dependent Variable: YIELD_DIFFERENCE
Method: Panel Least Squares
Date: 04/28/21 Time: 14:50
Sample: 11/26/2013 12/31/2020
Periods included: 1853
Cross-sections included: 57
Total panel (unbalanced) observations: 35829

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.170584	0.003288	51.88560	0.0000
DELTA_BID_ASK_SPREAD	0.441196	0.007273	60.65855	0.0000

Effects Specification

Cross-section fixed (dummy variables)

Root MSE	0.611962	R-squared	0.270914
Mean dependent var	0.135231	Adjusted R-squared	0.269752
S.D. dependent var	0.716706	S.E. of regression	0.612458
Akaike info criterion	1.858944	Sum squared resid	13417.87
Schwarz criterion	1.872682	Log likelihood	-33244.06
Hannan-Quinn criter.	1.863315	F-statistic	233.1891
Durbin-Watson stat	0.313474	Prob(F-statistic)	0.000000

Table 5. Hausman test. Hausman test says that the individual effects correlate with the explanatory variable and the probability-value is statistically significant at 1 % level. Thus, we use the fixed effect estimator.

Dependent Variable: YIELD_DIFFERENCE
Method: Panel Least Squares
Date: 04/30/21 Time: 16:03
Sample (adjusted): 11/27/2013 12/31/2020
Periods included: 1852
Cross-sections included: 57
Total panel (unbalanced) observations: 35772

Variable	Coefficient	Std. Error	t-Statistic	Prob.
YIELD_DIFFERENCE(-1)	0.893082	0.002337	382.2198	0.0000
C	0.016981	0.001714	9.906307	0.0000
DELTA_BID_ASK_SPREAD	0.038333	0.002833	13.53312	0.0000

Root MSE	0.314791	R-squared	0.806863
Mean dependent var	0.134756	Adjusted R-squared	0.806853
S.D. dependent var	0.716301	S.E. of regression	0.314804
Akaike info criterion	0.526351	Sum squared resid	3544.766
Schwarz criterion	0.527063	Log likelihood	-9411.322
Hannan-Quinn criter.	0.526578	F-statistic	74715.72
Durbin-Watson stat	2.397847	Prob(F-statistic)	0.000000

Table 6. Yield difference $\Delta\tilde{n}_{i,t}$ with the lagged value. $\boldsymbol{\Delta}\tilde{n}_{i,t} = \Delta\tilde{n}_{i,t}.(-1) + s_i + \beta\ \Delta\text{Liquidity}_{i,t} + \omega_{i,t}$ while $\omega_{i,t}$ being the error term with fixed effect panel regression.

Dependent Variable: YIELD_DIFFERENCE
Method: Panel Least Squares
Date: 05/05/21 Time: 10:11
Sample (adjusted): 11/27/2013 12/31/2020
Periods included: 1852
Cross-sections included: 57
Total panel (unbalanced) observations: 35772
Period SUR (PCSE) standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.016981	0.005964	2.847334	0.0044
YIELD_DIFFERENCE(-1)	0.893082	0.012036	74.20041	0.0000
DELTA_BID_ASK_SPREAD	0.038333	0.008016	4.782336	0.0000

Root MSE	0.314791	R-squared	0.806863
Mean dependent var	0.134756	Adjusted R-squared	0.806853
S.D. dependent var	0.716301	S.E. of regression	0.314804
Akaike info criterion	0.526351	Sum squared resid	3544.766
Schwarz criterion	0.527063	Log likelihood	-9411.322
Hannan-Quinn criter.	0.526578	F-statistic	74715.72
Durbin-Watson stat	2.397847	Prob(F-statistic)	0.000000

Table 7. Yield difference $\Delta\tilde{n}_{i,t}$ with the lagged value and with PCSE. $\Delta\tilde{n}_{i,t.} = \Delta\tilde{n}_{i,t.}(-1) + s_i + \beta \Delta\text{Liquidity}_{i,t} + \omega_{i,t}$ while $\omega_{i,t}$ being the error term with fixed effect panel regression.

As Zerbib (2019) notes we are controlling the yield difference by the liquidity difference. This enables that we are not facing any simultaneity effects: the difference between the yields does not have retroactive effect on the liquidity of the bonds. We use the Beck-Katz robust estimation of the standard errors also in the Table 7. While observing the test it seems that there is positive green bond premium of 1,7 basis points. This means that green bonds are being sold by discount.

4.2 Further tests

We are running still some further test to find out if some other variables have an effect on to the results. We are using the rating, the currency, the maturity and the issue amount of the green bond and also the sector of the issuer. We are running an OLS regression and some robust estimation of the standard errors. We are running a OLS regression with dummy variables:

$$\hat{s}_i = a_0 + a_1 \text{Swedish Krona} + a_2 \text{RatingAAA} + a_3 \text{Financial Institution} + a_4 \text{Maturity} + a_5 \log(Issue\ amount) + \omega_{i,t}$$ while $\omega_{i,t}$ being the error term. (4)

Dependent Variable: C
Method: Panel Least Squares
Date: 05/04/21 Time: 11:23
Sample (adjusted): 11/26/2013 11/05/2020
Periods included: 46
Cross-sections included: 48
Total panel (unbalanced) observations: 48

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RATING_AAA	-0.044593	0.017193	-2.593590	0.0129
SWEDISH_KRONA	0.070172	0.013250	5.296126	0.0000
FINANCIAL_INSTITUTI	-0.015468	0.010525	-1.469699	0.1489
MATURITY	-0.000510	0.003893	-0.131056	0.8963
LOG(ISSUE_AMOUNT)	0.053092	0.001500	35.38991	0.0000

Root MSE	0.028743	Mean dependent var	1.000000
S.D. dependent var	0.000000	S.E. of regression	0.030368
Akaike info criterion	-4.052511	Sum squared resid	0.039656
Schwarz criterion	-3.857594	Log likelihood	102.2603
Hannan-Quinn criter.	-3.978852	F-statistic	-10.75000
Durbin-Watson stat	0.000000	Prob(F-statistic)	1.000000

Table 8. The estimated green bond premium with a OLS regression. We use dummy variables that represent the most common variables among our sample.

It seems that there is a serial correlation in the Table 8 according to Durbin-Watson and because of this reason we are running the regression analysis with Beck-Katz robust estimations of the standard errors because it should be a good tool in small panels and the results are in the Table 9.

Dependent Variable: C
Method: Panel Least Squares
Date: 05/05/21 Time: 10:16
Sample (adjusted): 11/26/2013 11/05/2020
Periods included: 46
Cross-sections included: 48
Total panel (unbalanced) observations: 48
Period SUR (PCSE) standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RATING_AAA	-0.044593	0.016861	-2.644646	0.0114
SWEDISH_KRONA	0.070172	0.017397	4.033511	0.0002
FINANCIAL_INSTITUTI	-0.015468	0.011468	-1.348807	0.1845
MATURITY	-0.000510	0.003586	-0.142309	0.8875
LOG(ISSUE_AMOUNT)	0.053092	0.001508	35.21045	0.0000

Root MSE	0.028743	Mean dependent var	1.000000
S.D. dependent var	0.000000	S.E. of regression	0.030368
Akaike info criterion	-4.052511	Sum squared resid	0.039656
Schwarz criterion	-3.857594	Log likelihood	102.2603
Hannan-Quinn criter.	-3.978852	F-statistic	-10.75000
Durbin-Watson stat	0.000000	Prob(F-statistic)	1.000000

Table 9. The estimated green bond premium with a OLS regression and PCSE. We use dummy variables that represent the most common variables among our sample.

We are also running a OLS regression with other dummy variables:

$$\hat{s}_i = a_0 + a_1 \text{Other currencies than Swedish Krona} + a_2 \text{Other rating than AAA} + a_3 \text{Other sector than Financial Institution} + a_4 \text{Maturity} + a_5 \log(Issue\ amount) + \omega_{i,t} \quad (5)$$

while $\omega_{i,t}$ being the error term.

It seems that there is a serial correlation in the Table 10 according to Durbin-Watson and because of this reason we are running the regression analysis with Beck-Katz robust estimations of the standard errors because it should be a good tool in small panels and the results are in the Table 11.

Dependent Variable: C
Method: Panel Least Squares
Date: 05/04/21 Time: 11:24
Sample (adjusted): 11/26/2013 11/05/2020
Periods included: 46
Cross-sections included: 48
Total panel (unbalanced) observations: 48

Variable	Coefficient	Std. Error	t-Statistic	Prob.
OTHER_RATING_THAN_AAA	0.057612	0.016214	3.553340	0.0009
OTHER_CURRENCIES	-0.062339	0.014077	-4.428366	0.0001
OTHER_THAN_FINANCIAL_INSTITUTION	0.020020	0.010315	1.940818	0.0589
MATURITY	-0.000823	0.003882	-0.212045	0.8331
LOG(ISSUE_AMOUNT)	0.052933	0.001512	35.00190	0.0000

Root MSE	0.028668	Mean dependent var	1.000000
S.D. dependent var	0.000000	S.E. of regression	0.030289
Akaike info criterion	-4.057760	Sum squared resid	0.039448
Schwarz criterion	-3.862843	Log likelihood	102.3862
Hannan-Quinn criter.	-3.984100	F-statistic	-10.75000
Durbin-Watson stat	0.000000	Prob(F-statistic)	1.000000

Table 10. The estimated green bond premium with a OLS regression. We use dummy variables that represent the remaining variables of our sample.

Dependent Variable: C
Method: Panel Least Squares
Date: 05/05/21 Time: 10:18
Sample (adjusted): 11/26/2013 11/05/2020
Periods included: 46
Cross-sections included: 48
Total panel (unbalanced) observations: 48
Period SUR (PCSE) standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
OTHER_RATING_THAN_AAA	0.057612	0.016326	3.528933	0.0010
OTHER_CURRENCIES	-0.062339	0.017438	-3.574839	0.0009
OTHER_THAN_FINANCIAL_INSTITUTION	0.020020	0.011431	1.751367	0.0870
MATURITY	-0.000823	0.003663	-0.224698	0.8233
LOG(ISSUE_AMOUNT)	0.052933	0.001433	36.94583	0.0000

Root MSE	0.028668	Mean dependent var	1.000000
S.D. dependent var	0.000000	S.E. of regression	0.030289
Akaike info criterion	-4.057760	Sum squared resid	0.039448
Schwarz criterion	-3.862843	Log likelihood	102.3862
Hannan-Quinn criter.	-3.984100	F-statistic	-10.75000
Durbin-Watson stat	0.000000	Prob(F-statistic)	1.000000

Table 11. The estimated green bond premium with a OLS regression and PCSE. We use dummy variables that represent the remaining variables of our sample.

We are following Zerbib (2019) and using logarithm of the issue amount to linearize the values of the variable that can be interpolated by an exponential function. We are using dummy variables to represent currency, rating and sector to find if they change the values.

5 Results

5.1 Positive green bond premium

We are estimating the green bond premium, its significance, sign and magnitude. We use Hausman test to find out that the fixed effect estimator is better than random effect model. We cannot say that the within estimator is unbiased and consistent because we can see that the Durbin-Watson states that there is a serial correlation. However we are getting the same results while we are using the lagged dependent variable (Table 7) and while the Durbin-Watson is much better.

Mean	0.001265
Median	-1.13E-14
Maximum	0.893082
Minimum	-1.13E-14

Table 12. The estimated green bond premium in our fixed effect regression: $\Delta\tilde{n}_{i,t} = s_i + \beta\,\Delta\text{Liquidity}_{i,t} + \omega_{i,t}$ while $\omega_{i,t}$ being the error term with fixed effect panel regression.

The regression evidences a high R^2 when using bid-ask differential to control the difference in liquidity. This means that a 1 basis points increase in the bid-ask spread price differential trigger a 1.7 basis points increase in $\Delta\tilde{n}_{i,t}$. The Table 12 shows us that the distribution of the premia of the green bonds varies quite much and it gets also negative values but the mean is positive.

We used also rating, sector and currency in our regression analysis because they are the main characteristics of a bond. We calculated premium with the most common variable in our sample: swedish crowns and that the issuer type is a financial institution. We also use AAA rating as a dummy variable in our regression in the Table 8. We can see that if a company is a AAA rated it is negatively correlated with the $\hat{s}_i$ same as if the issuer is a financial institution. It seems that maturity is also negatively correlated with the $\hat{s}_i$. Swedish crowns are positively correlated with the $\hat{s}_i$.

The Table 10 notes also that other ratings than AAA are positively correlated with the premium. We have to note that quite much of the sample is N/A and we do not have better perception of the sample so this can bias our results. Other currencies are negatively correlated with the premium but we have to understand that most of the bonds of the sample are issued in Swedish crowns so they represent a big sampling of the sample. Issuers that are not financial institution are positively correlated with the premium. Maturity seems to have a negative effect on to the premium in the Table 8 and also in the Table 10. Issue amount is positively correlated with the premium in the Table 8 and also in the Table 10. Maturity seems to be statistically insignificant in our Tables (8 - 11) and also financial institutions as a dummy variable seems to be statistically insignificant.

5.2 Checking the robustness

We test the robustness. Zerbib (2019) notes that the negative green premium can reflect the fact that they are less riskier than conventional bonds. We are calculating the 10-day and 30-day rolling annualized volatility during the period of interest regarding the green bonds and the synthetic bonds. We follow the equation (3) modified to the volatility and take the difference between the green bond and the synthetic bond. After this we are running the equation (2) and we add the difference in volatility as an independent variable. We use also Beck-Katz robust estimations of the standard errors and we find no evidence that a difference in volatility is not a result from the yield differential between the green and conventional bonds. Thus, the green bond premium should differ from a risk premium. Table 13 and Table 14 note that the green bond premium does not differ that much with the volatility dependent variable. We can see from the Table 15 and Table 16 that without lagged dependent (and Beck-Katz robust estimation of the standard errors) variable there is a serial correlation.

Dependent Variable: YIELD_DIFFERENCE
Method: Panel Least Squares
Date: 05/06/21 Time: 14:36
Sample (adjusted): 11/27/2013 12/31/2020
Periods included: 1697
Cross-sections included: 44
Total panel (unbalanced) observations: 6926
Period SUR (PCSE) standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.013421	0.002670	5.025994	0.0000
YIELD_DIFFERENCE(-1)	0.961024	0.009279	103.5692	0.0000
DIFFERENCE_BETWEEN_10_DAY_DATA	0.000470	0.000643	0.731375	0.4646
DELTA_BID_ASK_SPREAD	0.032687	0.006125	5.336978	0.0000

Effects Specification			
Cross-section fixed (dummy variables)			
Root MSE	0.146785	R-squared	0.976552
Mean dependent var	0.278591	Adjusted R-squared	0.976395
S.D. dependent var	0.958653	S.E. of regression	0.147285
Akaike info criterion	-0.986127	Sum squared resid	149.2259
Schwarz criterion	-0.939690	Log likelihood	3461.959
Hannan-Quinn criter.	-0.970117	F-statistic	6228.188
Durbin-Watson stat	2.300952	Prob(F-statistic)	0.000000

Table 13. The equation (2) estimated green bond premium with 10-day annualized volatility and a lagged dependent variable with Beck-Katz robust estimations of the standard errors.

Dependent Variable: YIELD_DIFFERENCE
Method: Panel Least Squares
Date: 05/06/21 Time: 14:38
Sample (adjusted): 11/27/2013 12/31/2020
Periods included: 1625
Cross-sections included: 39
Total panel (unbalanced) observations: 5456
Period SUR (PCSE) standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.014709	0.003823	3.847343	0.0001
YIELD_DIFFERENCE(-1)	0.957671	0.012773	74.97654	0.0000
DIFFERENCE_BETWEEN_30_DAY_DATA	-0.000575	0.000773	-0.743597	0.4572
DELTA_BID_ASK_SPREAD	0.030328	0.008613	3.521177	0.0004

Effects Specification

Cross-section fixed (dummy variables)

Root MSE	0.148021	R-squared	0.978738
Mean dependent var	0.331393	Adjusted R-squared	0.978577
S.D. dependent var	1.015218	S.E. of regression	0.148594
Akaike info criterion	-0.967523	Sum squared resid	119.5429
Schwarz criterion	-0.916682	Log likelihood	2681.404
Hannan-Quinn criter.	-0.949783	F-statistic	6078.416
Durbin-Watson stat	2.382852	Prob(F-statistic)	0.000000

Table 14. The equation (2) estimated green bond premium with 30-day annualized volatility and a lagged dependent variable with Beck-Katz robust estimations of the standard errors.

Dependent Variable: YIELD_DIFFERENCE
Method: Panel Least Squares
Date: 05/10/21 Time: 09:36
Sample: 11/26/2013 12/31/2020
Periods included: 1699
Cross-sections included: 44
Total panel (unbalanced) observations: 6942

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.345180	0.006936	49.76600	0.0000
DIFFERENCE_BETWEEN_10_DAY_DATA	-0.015431	0.001691	-9.125032	0.0000
DELTA_BID_ASK_SPREAD	0.611287	0.012414	49.24023	0.0000

Effects Specification

Cross-section fixed (dummy variables)

Root MSE	0.565446	R-squared	0.652384
Mean dependent var	0.279252	Adjusted R-squared	0.650115
S.D. dependent var	0.959119	S.E. of regression	0.567329
Akaike info criterion	1.710849	Sum squared resid	2219.560
Schwarz criterion	1.756208	Log likelihood	-5892.356
Hannan-Quinn criter.	1.726486	F-statistic	287.5992
Durbin-Watson stat	0.228729	Prob(F-statistic)	0.000000

Table 15. The equation (2) estimated green bond premium with 10-day annualized volatility.

Dependent Variable: YIELD_DIFFERENCE
Method: Panel Least Squares
Date: 05/10/21 Time: 09:37
Sample: 11/26/2013 12/31/2020
Periods included: 1628
Cross-sections included: 39
Total panel (unbalanced) observations: 5469

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.377692	0.007278	51.89418	0.0000
DIFFERENCE_BETWEEN_30_DAY_DATA	-0.033297	0.002345	-14.19870	0.0000
DELTA_BID_ASK_SPREAD	0.588526	0.014346	41.02428	0.0000

Effects Specification

Cross-section fixed (dummy variables)

Root MSE	0.530348	R-squared	0.727365
Mean dependent var	0.332292	Adjusted R-squared	0.725356
S.D. dependent var	1.015804	S.E. of regression	0.532348
Akaike info criterion	1.584428	Sum squared resid	1538.262
Schwarz criterion	1.633958	Log likelihood	-4291.619
Hannan-Quinn criter.	1.601709	F-statistic	362.0344
Durbin-Watson stat	0.252873	Prob(F-statistic)	0.000000

Table 16. The equation (2) estimated green bond premium with 30-day annualized volatility.

6 Conclusion

We find the positive green bond premium vice versa as we believed in. We analyzed the green bond versus an equivalent synthetic conventional bond. We used the matching method with some slight adjustments to the maturities of the bonds because our data was a bit narrow and we could not use the exact same methods as Zerbib (2019). The adjustments resulted probably some bias in our analysis because there is serial correlation that we correct with lagged dependent variable. The probabilities of the results are also almost too good to be true and the R-squared is rather high.

However our result is that there is a non negative premium but the positive premium is quite small. The premium is defined as Zerbib (2019) that it is a yield difference between the green bond and the conventional bond after controlling the difference in liquidity. Our sample consist of bonds that are issued in the Nordics. Most of the issued green bonds are from Sweden.

We thought that we would find also a negative premium as Zerbib (2019). The negative premium would have stated "the fact that the buying pressure relative to the supply capacity in the case of green bonds is greater than that in conventional bonds" (Zerbib (2019)). The negative premium can also explain the stakeholder theory that a better environmental performance decreases the cost of capital (Zerbib (2019)). Issuer could benefit of the negative green bond premium. The market is ready to take more green debt and to offer a primary yield that is a bit lower than the conventional bond (Zerbib (2019)). Our result is opposite of the aforementioned and it seems that the green bonds are being sold by discount and the buyers would benefit from this situation. This would mean also that it is more expensive to issue green bonds than conventional bonds.

We note also that the median premium was negative but the mean was slightly positive. When the issued bonds are in Swedish crowns it has a positive impact like if the issuer is something else than a financial institution. Issue amount seems to have a

positive impact also to the premium. Zerbib (2019) notes that the negative premium is larger for financial bonds and it seems that our results state the same.

The most largest limitations of our research is the data. The data is so narrow that we were not able to use all the same methods as Zerbib (2019) but we wanted study the Nordics because the Nordic countries are often pioneers in sustainable development and also well organized and trustworthy. In the future there will be more green bonds and there is available data from a longer time period and further researchs can be done also in the Nordics regarding the green bonds.

Due to results of our paper we cannot state that the issuers are able to get cheaper financing through green bonds because our premium was positive even though just slightly. The buyers would be able to buy green bonds with a discount.

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