SCHOOL OF BUSINESS, ECONOMICS AND LAW
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MASTER OF SCIENCE IN FINANCE

A Yield Spread Analysis of the Green Bond Premium and Liquidity in the Swedish Green Bond Market

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Abstract

This study investigates green bond premium and liquidity in the Swedish SEK green bond market. Through a matching pair's methodology with 101 green Swedish SEK Green bonds and conventional counterparts, the yield spread is analyzed through a liquidity risk and a green bond premium perspective. The results of the Swedish SEK green bond sample suggest that green bonds compensate for liquidity and that corporate green bonds seem to be more liquid than their conventional counterparts. The results did not show enough significance on the green bond premium. Hence, no answer on whether green bonds have a higher or lower return solely because of the fact that they are green can be given. The regression results of the green bond premium, however, suggest that the predominant determinants of the size of the green bond premium seem to be whether the bond is a corporate or municipal bond and what type of sector the bond is associated with.

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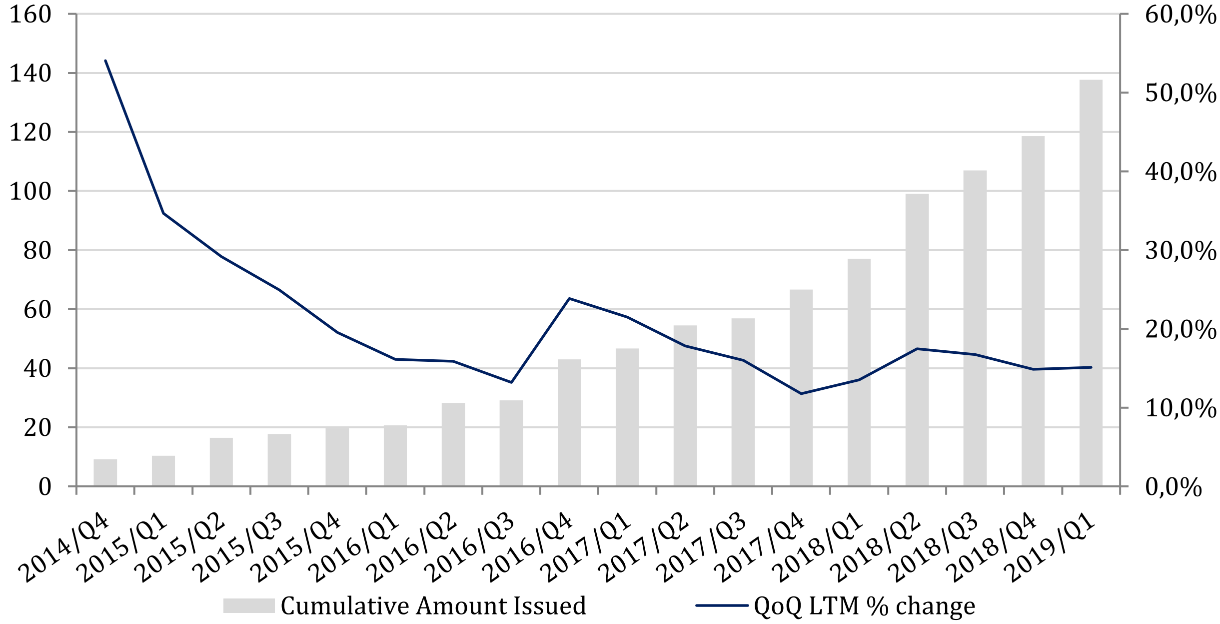
1. Introduction

The concept of green bonds was first introduced in 2007-2008 by the Swedish bank SEB and the World bank. The reason for the development of these new bonds was an increased demand for climate-related investment opportunities (SEB, 2012). Green Bonds are much like conventional bonds- a debt instrument used as financing for private or public actors. The difference with green bonds is that next to all of the proceeds have to be put into green projects, assets or business undertaken by the issuer (Jun et al., 2016). To attain a green bond label there are basically two options. The issuer could either self-label its bond or have independent reviewers label the bond as green. To this day, the most widely accepted standards to evaluate an aspiring green bond according to is the Green Bond Principles and the Climate Bond Standards (Jun et al., 2016). The Climate Bond Initiative (hereafter *"CBI"*) states that a green bond is a bond labeled green by the issuer and that commit at least 95% of the proceeds to green assets and sufficient information on the financed projects is available (CBI, 2018b).

In 2017 the total global issuance of green bonds hit an all-time record of USD 155.5 billion, which nevertheless was a growth of 78% on the total global issuance of 2016 (CBI, 2018a). The market continued to grow during 2018 and amounted to $389 billion green bonds outstanding globally in September 2018 (CBI, 2018b). According to the report *Green Bonds- Ecosystem, Issuance Process and Case Studies* by Kaminker et al. (2018), the OECD finds that restricting the global temperature changes will require investments of USD 6,9 trillion per year in infrastructure projects until the year of 2030. Thus, there is no doubt that there is a huge need for green financing forms, which motivates further research into whether green bonds could be a viable tool for financing green projects.

One of the countries where green bond development has been particularly remarkable is Sweden, with a solid market growth driven by strong issuance of Swedish SEK green bonds the past 5 years illustrated in Figure 1. A remarkable amount of approximately 140 billion SEK in total has been issued in Sweden in order to finance green projects until the end of the first quarter 2019. Between 2017 and 2018 the issued amount in SEK green bonds rose by 84%, from 38 billion SEK to 70 billion SEK, which constituted 10% of the total Swedish bond market (Danske Bank, 2019). Nevertheless, the outlook for 2019 is very promising as the SEK green bond issuance accounted for as much as 28% out of the total SEK bond issuance during the first quarter (SEB, 2019). Nevertheless, Sweden comes in as the seventh largest green bond issuer, which is noteworthy because of the fact that the countries ahead are much larger countries such as the United States, China and, France (CBI, 2018).

Figure 1: Cumulative Swedish green bond issuance in billion SEK. The figure below shows the cumulative Swedish green bond issuance in billions of SEK. The staples show the absolute cumulative amount issued and the line shows the quarter on quarter last twelve-month percentage change.



Source: Bloomberg.

Aside from the strong development of green bonds over the past 10 years, there are also some identified bottlenecks that could create problems for further expansion of the market. Cochu et al. (2016) stated that green bonds are likely to be perceived as being riskier than conventional bonds because green bonds often concern funding of new and less mature technology. In addition, Della Croce et al. (2011) held that even though there are plenty of investment grade green bonds at similar yield levels as conventional bonds, green bonds still carry a higher liquidity risk. To address issues such as those Cochu et al. (2016) and Della Croce et al. (2011) pointed out, studies of whether there are any significant yield or liquidity differences between green and conventional equal bonds are relevant. Previous literature (see for example Zerbib (2019), Bachelet et al. (2019) and Gianfrate et al. (2019)) has therefore investigated the yield spread between green and conventional bonds to see whether green bonds compensate for lower liquidity levels and whether there is a green bond yield premium. Zerbib (2019) defined a negative green bond premium as an indication of that there is a green preference amongst investors; investors are willing to receive a lower yield in order to invest sustainably.

This study investigates the yield spread between Swedish SEK green bonds and conventional equal counterparts to determine whether there are significant differences in the yields. The aim of this study is therefore to recognize whether green bonds compensate for liquidity, whether there is a green bond premium and if so, what factors determine the level of this premium. By analyzing the yield spread the purpose of this study is to outline whether the Swedish SEK green bond yields are different from Swedish SEK conventional bond yields and answer the following three research questions:

- *Do Swedish SEK green bonds compensate for liquidity risk?*
- *Is there a Swedish green preference?*
- *What determines the green bond premium?*

Answering these questions will give a good understanding of whether Swedish green bond yields are structured as conventional bond yield or possess a special green bond premium, which drives the green bonds to pay more or less in yield just because of the fact that they are "green". Outlining eventual differences in the green and conventional bond yield will nevertheless give indications of whether the Swedish SEK green bonds seem to be a persisting tool for the great demand of sustainable financing.

There are to this day a very limited amount of previous research in green bonds and therefore we recognize a need for additional studies. This study will contribute to the green bond research by studying the yield spread between Swedish SEK green and conventional bonds. Most previous green bond yield spread analysis has been performed on a more aggregated basis such as on the USD and euro bond markets. There are, to our knowledge, no published yield spread analysis of only Swedish SEK green bonds today. This study will follow the method of Zerbib (2019) where the green bond premium is retrieved from a regression where the yield spread is controlled for difference in liquidity and then analyzed in an OLS regression. The explanatory variables in both regression steps is however adapted to fit the matching method and theory of this study.

The rest of this study is structured as follow: section 2 reviews the previous research on green bond yield spreads and set up a theoretical framework to support our explanatory variables, section 3 develops and outlines the hypothesis on what we expect to find based on the literature review and bond theory, section 4 introduces the matching method which will be used to retrieve the green bond yield spread as well as describes the data collection and specifies the econometric model designs, section 5 presents and analyses the results and main findings, and, finally, section 6 presents the conclusion and discusses suggestions for further research.

2. Literature review and theoretical framework

2.1 Previous research

Veys (2010) did an early research of the green bond liquidity and emphasized the importance of liquidity of any security since it allows investors to change their portfolio structure and adapt to changing market conditions. By studying the liquidity of green bonds in the Sterling bond market Veys (2010) found no evidence on that green bonds compensate for low liquidity via a liquidity premium as conventional bonds do. Veys (2010) also described green bonds, by that time, to only attract a small segment of investors and to also be a riskier investment as the issues was in general relatively small and put into riskier projects. The early research by Veys (2010) also suggested that the majority of green bonds financed renewable energy projects and therefore came out as high yield bonds due to the volatile cash flows and high cost of capital.

The green bond research during the last couple of years suggest findings and conclusions that are to a great extent in contrast to those of Veys (2010). Wulandari et al. (2017) analyzed the liquidity yield premium in 64 labeled green bonds listed on the London and Luxembourg Stock Exchanges using the bid-ask spread and LOT liquidity measure in a fixed effect panel regression and a pooled OLS regression. In contrast to their initial hypothesis of that green bonds express lower liquidity due to a buy and hold strategy, the results showed the opposite relationship. The results indicated that the green bonds in the sample were more liquid than their conventional counterparts between 2014 and 2016. The findings also showed a positive correlation between the liquidity measures and the yield spread. This correlation concluded that if an individual green bond was less liquid than the conventional counterpart, this was compensated with a liquidity premium.

Recent academic research has started to focus more on matching approaches where the green bond yield is compared to the bond yields of conventional equal counterparts. Bachelet et al. (2019) analyzed 89 bonds pairs[1] globally and similarly concluded that the green bonds showed to be more liquid than their conventional counterparts, with a 6 basis points (hereafter *"bps"*). tighter yield spread on average. In addition, Bachelet et al. (2019) analyzed the liquidity further by breaking down the bond sample in groups of private and institutional issuers. The result showed that only

[1] A green bond matched with a similar conventional bond.

green bonds issued by institutional issuers were more liquid than their conventional counterparts. If the green bond was issued by a private issuer the green bond also had to be externally certified to be more liquid than their conventional counterpart. Uncertified green bonds issued by private issuers showed to be less liquid than their conventional counterparts. By matching 110 green bonds denominated in EUR and USD with a conventional counterpart Zerbib (2019) found on average a slight negative green bond premium of -2 bps. The results also showed that the negative premium was more prominently found in bonds issued by financial institutions rather than bonds issued by companies in the utilities sector or government bonds. Nonetheless, the lower rating a bond issued by a financial institution had, the more negative was the premium. Similarly, in a study of 121 EUR denominated green bonds between 2013 and 2017, Gianfrate (2019) found a negative green bond premium of -18 bps at issuance. The results also showed that the negative premium was maintained in the secondary market and Gianfrate (2019) therefore concluded that green bonds should be preferred by issuers since they carry a cheaper cost of debt compared to conventional bonds.

In contrast to the findings by Zerbib (2019) and Gianfrate (2019), Hyun et al. (2018) found no evidence for any green bond premium in a study of 60 GBP-labeled green bonds, Bachelet et al. (2019) found evidence of a positive premium on average and Baker et al. (2018) likewise found that U.S green municipal bonds were issued at a premium. However, in a breakdown of the results, Hyun et al. (2018) found that there was evidence for a small negative green bond premium in green bonds that had been certified by either an external reviewer or the CBI. Similarly, Bachelet et al. (2019) found evidence of a negative green bond premium of the green bonds in their sample that was either issued by an institutional issuer or private issuers that had their bond certified as green. Bachelet et al. (2019) concluded that the difference in premium between the different green bond characteristics to be a result of the information asymmetry present in the green bond market. Karpf and Mandel (2018) likewise recognized that U.S municipal bonds have been penalized on the green bond market, trading at lower prices and higher yields than what could have been expected from the associated credit profiles. In conclusion of previous findings, there seem not yet to be a consensus of whether green bond carry a premium and if they do if it is positive or negative, which motivates further research into the green bond yield spread.

2.2 Bond theory

To analyze the green bond yield spread, a theoretical framework of what has been proven to affect bond yields is essential. The yield spread is derived through the following formula, where green bond yield to maturity is subtracted by the conventional bond yield to maturity.

Formula 1: Green bond yield spread

$$Yield\ spread_t = \frac{\overbrace{C_{x,i}^{GB} + \frac{F_{x,i}^{GB} - P_{x,i,t}^{GB}}{n_t}}^{YTM_{x,i,t}^{GB}}}{\frac{F_{x,i}^{GB} + P_{x,i,t}^{GB}}{2}} - \frac{\overbrace{C_{z,i}^{CB} + \frac{F_{z,i}^{CB} - P_{z,i,t}^{GB}}{n_t}}^{YTM_{z,i,t}^{CB}}}{\frac{F_{z,i}^{CB} + P_{z,i,t}^{GB}}{2}}$$

$C_{x,i}^{GB}$ =Coupon rate on green bond x issued by i
$C_{z,i}^{CB}$ =Coupon rate on conventional bond z issued by i
$F_{x,i}^{GB}$ =Face Value of green bond x, issued by i
F^{CB} = Face Value of conventional bond z, issued by i
$P_{x,i,t}^{GB}$ =Price of green bond x, issued by i, at time t
$P_{z,i,t}^{GB}$ = Price of conventional bond z, issued by i, at time t
n_t =Number of years to maturity
$YTM_{x,i,t}^{GB}$ =Yield to maturity of green bond x, issued by i, at time t
$YTM_{z,i,t}^{CB}$ = Yield to maturity of conventional bond z, issued by i, at time t
$Yield\ spread_t$ =Depicts yield spread between green bond x and conventional bond y, issued by i, at time t

Source: Approximate yield to maturity formula from Smith (2014). Own construction into green bond yield spread.

Key determinants for bond yields will outline a theoretical framework of potential components that might affect the yield spread between green and conventional bonds and to what extent.

2.2.1 Term structure

Cox et al. (1985) examine the term structure of interest rates and discusses the subject of *term premium*[2]. The term structure of interest rates depicts the connection between the yields on default free securities amongst different time to maturities. The term structure demonstrates market expectations of forthcoming economic events and, to a certain extent, forecasts in what way correlated variables will affect the yield curve structure. In bond theory, the yield is predominantly used when referring to the bond returns, rather than the prices as in other financial markets (Cox et al., 1985).

[2] Term premium refers to the additional yield for investing in long term securities

Hicks emphasizes investors' risk preferences and argues that risk aversion leads to greater forward rates than expected spot rates. The spread between these rates generally decreases as the bond approaches maturity. He refers to this premium as a term premium that is required to make market participants willing to invest in long-term securities, which implies higher risk. The expected return for short-term bonds can be forecasted with significantly higher certainty than for long-term bonds, hence a lower yield is required for investing in short term securities. (Cox et al., 1985). Moreover, Cox et al. (1985) conclude that the shape of the yield curve depends on investors' risk aversion and investment alternatives available.

2.2.2 Duration

The subject of years to maturity and bond yield has been further examined by Frederik R Macauley (1938). The tenor and maturity date only depict the time length of the bond, but do not give any information regarding the timing and size of the individual interest payments, known as coupons (Malkiel, 1962). Macaulay (1938) developed the commonly known concept of *duration* in order to depict the true length and underlying risk of fixed income securities. The duration, known as the Macaulay duration, is calculated through a weighted average of the maturities of the debt which are connected to each separate coupon. When the time to maturity increases, so does the bond duration at a diminishing pace, hence a diminishing yield. The duration generally depicts how long it takes for the investor to regain a bond's true costs through the separate coupon payments. The higher duration a bond has, the higher is the interest rate risk for bond prices (Malkiel, 1962; Macaulay, 1938). The bond duration is an indicator of the credit default risk and the interest rate risk for fixed income securities (Macaulay, 1938).

2.2.3 Credit Risk Premium

The default risk premium, the additional yield for taking on credit risk, depends on several factors where one is the bond's time to maturity. The default risk generally increases with a longer time to maturity (Brigham and Daves, 2007). Investors require a lower bond price with a higher probability of default of the debt instrument. In general, Treasury bills and bonds carries zero default risk, whereas municipal and corporate bonds have some level of default probability depending on the creditworthiness, reflected in the credit rating (Brigham and Daves, 2007). Credit ratings have been assessed since the early 1900's by the three major credit institutions S&P,

Moody’s, and Fitch and reflect a bond issuer’s ability to follow their loan obligations. A lower credit rating implies a higher default risk and bonds with higher default risk have in general higher coupon rates. (Brigham and Daves, 2007).

2.2.4 Liquidity risk

The Hicksian liquidity premium refers to the fact that short-term securities are more liquid than long-term securities due a to higher capital certainty when closer to maturity (Cox et al., 1985). The liquidity risk indicates how quickly a financial instrument can be converted into cash and generally refers to the differential between a short maturity and a longer maturity fixed income security. The higher risk associated with long-term securities calls for higher required yield by investors, which creates an upward sloping curvature on the bond yield curve (Cox et al., 1985). The excess yield is referred to as the liquidity premium (Mishkin and Eakins, 2012). Thus, the liquidity premium theory implies that a yield premium is present for long-term bonds compared to short maturity bonds. Risk-averse investors generally require an additional yield, i.e. a liquidity premium for taking on liquidity risk and invest in long maturity bonds (Mishkin and Eakins, 2012). Without existence of a liquidity premium for taking on an additional risk, the yield curve would be horizontal and the demand for long maturity bonds would consequently be lower than for short maturity bonds (Cox et al., 1985).

3. Hypothesis development

From the literature review and bond theory, we develop the following hypothesis of what we predict our yield spread analysis will find:

- *Hypothesis 1: Swedish green bonds compensate for liquidity risk but are on average more liquid than conventional counterparts.*

From the Hicksian liquidity premium theory, we know that investors holding illiquid securities should be compensated with a liquidity premium. In contrast, Veys (2010) did not find any evidence on that green bonds compensate for liquidity risk as conventional bonds do. During the years since the findings of Veys (2010), the issuance volume has grown rapidly and the active amount outstanding is significantly higher. Thus, in a more well-established market, it is reasonable to believe that green bond yields will behave as conventional bond yields do and pay a liquidity premium. This assumption is in line with the recent research by, for example, Bachelet et al. (2019) and Wulandari et al. (2017), where a positive correlation between the liquidity difference and yield spread is found. Because of the recent findings in other bond markets and Sweden's strong green bond issue rate, our prediction is that the green bond yields follow the traditional bond theory of liquidity premium. Furthermore, we believe that the analysis will show that Swedish green bonds are more liquid than conventional counterparts because of the solid investor appetite for sustainable investment opportunities that seems to be present in Sweden.

- *Hypothesis 2: There is on average a green preference in the Swedish green bond market*.

When controlling for liquidity between green bonds and their conventional counterparts we predict that the remaining yield spread will be negative, which represents a negative green bond premium. The green bond premium represents the extra yield that is demanded from investors only because the bond is green. If the green bond premium is negative this indicates that there is a green preference in the Swedish green bond market, investors are willing to forego financial benefit in return for green benefits. If the green bond premium is positive this indicates that there is no particular green preference, investors rather demand a higher yield to be willing to hold green bonds. We believe that Sweden's powerful issuance and development of the green bond market is a response to strong demand for responsible investment opportunities.

- *Hypothesis 3: The green bond premium is determined by sector risk.*

According to the research by Veys (2010), green bonds issued by energy corporates often has a high yield credit rating, which attracts a smaller group of investors. Furthermore, Zerbib (2019) found that green utility bonds carried a higher green bond premium than green financial bonds. Similar to the conclusion of Bachelet et al. (2019), we believe that positive green bond premiums are driven by information asymmetry and therefore are more profound in sectors that are commonly associated with higher credit risk. We predict not only that strong demand for Swedish green bonds creates a green preference but also that demand is different for different green bonds. Our belief is that this prediction will be most evident in what sector the bond is associated with and what underlying credit worthiness can be connected to that sector.

4. Data and Methodology

4.1 Matched pair analysis

To investigate the green bond yield spread, a green and conventional bond yield differential must be aligned. One possibility would be to compare green and conventional bond indices. However, this method would lead to significant differences in the underlying bonds as there is a very limited amount of established green bond indices. This study will instead use a matched pair analysis to obtain the green bond yield spread. The principle of the matched pair analysis is to enable to detect differences between a security with a special characteristic by matching it with its conventional counterpart. Matching method approaches are nonetheless something that has been used in the earlier research of the green bond yield spread, see for example Zerbib (2019), Hyun et al. (2018) and Bachelet et al. (2019).

There are two drawbacks with the matching method. The first drawback is that it is practically impossible to find a perfectly similar conventional counterpart to the security of interest and the second drawback is that many matching restrictions will result in a small dataset and perhaps too few observations to be able to draw statistical conclusions. The latter being one drawback that is very relevant in green bond research because the accessible data is already very small to begin with.

The matching criterion chosen for this study were chosen to balance the trade-off between bond similarity and sample size. Because small samples and few observations are big challenges in green bond research, control variables are instead used for characteristics that were not restricted in the matching process. The matching criteria finally selected demanded issuer, currency, country of risk, coupon type and maturity type to be exactly the same for each pair of bonds. The bonds were furthermore matched as close as possible in time to maturity and all bond pairs that differed more than 12 months in maturity date were excluded.

4.2 Data Collection

All data was collected from the Bloomberg database where the green bonds were identified by the green bond search function. When restricting the sample of green bonds to only include bonds issued in SEK, 236 active and matured bonds were left in the sample. To ensure that each bond also was completely a part of the Swedish green bond market the sample was furthermore restricted to only include bonds with Sweden as the country of risk, which left the sample with 194 bonds. In order to not include bonds with special features, which may inflict the yield, the sample was also restricted to only include bullet bonds with either a fixed, floating or zero coupon. The final green bond sample came down to a subset of 182 bonds.

The conventional bonds were collected by searching for all active and matured bonds and imposing restrictions on issuer, currency, country of risk, coupon and maturity type to match with the green bond sample. A matching conventional bond for each green bond was then manually screened with respect to a maximum difference of 12 months in maturity date. For a number of green bonds, it was not possible to find a conventional bond that ticked off each matching criterion and therefore a pair could not be created. Thus, the final sample ended up in a total of 101 matched bond pairs (see appendix for list of bond pairs). Of these 101 matched pairs 72 are corporate bonds and 29 are municipal bonds. For each bond pair, monthly data was collected during the active period between 2013-01-01 and 2018-12-31 which generated a total of 1816 observations where 1198 of them are from corporate bonds and 618 of them are from municipal bonds.

4.3 Estimating the liquidity- and green bond premium

Following Zerbib (2019) the estimation of the green bond premium is done in a regression model where the yield spread is regressed against the difference in bid-ask spread of the green and conventional bonds. Because the bond pairs are matched to be as similar as possible the assumption is that the only difference, except for the fact that one of the bonds is green, is the liquidity. Thus, controlling for the liquidity difference when regressing the yield spread the green bond premium is, in line with Zerbib (2019), defined as the unobserved effect in the regression. The regression model in Zerbib (2019) is specified as follow:

$$Yield\ spread = \beta_0 + \beta_1 \Delta bidask + \varepsilon$$

Where ε is the error term and the yield spread is the dependent y-variable which is defined as:

$$Yield\ spread = y_{green} - y_{conventional}$$

Where y_{Green} is the green bond yield and $y_{Conventional}$ is the conventional bond yield. The yield spread was calculated for each observation for all pairs in the matched bond sample. The regressor $\beta_1 \Delta bidask$ is the proxy for the difference in liquidity and defined as:

$$\Delta bidask = bidask_{green} - bidask_{conventional}$$

The assumption in this regression model is that the only difference between the green and conventional bond is the level of liquidity. However, as previously mentioned, one drawback with the matching method is that it is practically impossible to find a perfectly matching bond pair. There will be differences within the two paired bonds, no matter how many restrictions are imposed in the matching process, and too many restrictions might result in a too small sample. In order to increase the sample size, we chose to relax the restrictions on issue amount and coupon rate. To account for these dissimilarities between the bonds we will, in addition to the regression done by Zerbib (2019), run a regression where the difference in issue amount and coupon rate are also controlled for. This additional regression model is specified as follow:

$$Yield\ spread = \beta_0 + \beta_1 \Delta bidask + \beta_2 \Delta issueamount + \beta_3 \Delta couponrate + \varepsilon$$

The regression and the unobserved effects will be estimated in an OLS regression where the standard errors are clustered at the bond issue level. The OLS regression will be run with three different samples. The first sample will be the full sample including both corporate and municipal bonds and the second and third sample will only include corporate and municipal bonds respectively. This approach is chosen to get an aggregated view of the Swedish SEK green bond market but also a breakdown of whether there is a premium difference between corporate and municipal bonds and, if so, how big it is.

4.4 Determinants of the green bond premium

Following Zerbib (2019) the green bond premium can be further investigated in an OLS regression. The aim with the second regression in this study is to recognize the primary drivers of the green bond premium. The green bond premium retrieved from the unobserved effect in the first regression will thus be regressed against variables that represent the bond theory presented in section 2. Issue amount, coupon rate and a dummy variable for coupon type are included to account for the drivers in the yield spread formula (see formula 1). A continuous variable for time to maturity and a discrete variable for years to maturity are included to incorporate any effect of the term structure theory. Macaulay duration is likewise set as a discrete variable to represent the theory of duration by Macaulay (1938). As we predict that the green bond premium is predominantly affected by investor demand we expect that sector risk will have the largest impact on the premium. To test this hypothesis industry is incorporated in the model as a dummy variable. Ideally, credit risk measures as default probability would have been included in the model but because of the limited availability of green bond data, this was not possible. Test regressions were also run when including rating as dummy variables but because a great majority of the sample consists of unrated bonds (see credit rating distribution in appendix) there were too few observations on some ratings to produce a solid model. The final regression model of the premium is specified below and the explanatory variables are defined in table 1.

$$premium = \beta_0 + \beta_1 issueamount + \beta_2 copuonrate + D_1 coupontype + \beta_4 timetomaturity + \beta_5 YTMissuance + \beta_6 duration + D_2 industry + \varepsilon$$

Table 1: Description of variables in the green bond premium regression. The table below defines the explanatory variables in the green bond premium regression. The units of measure are specified for each unit and the benchmarks for the dummy variables are presented.

VARIABLES	Description
Issue amount	The bonds issue size in 10 million SEK
Coupon rate	The annual coupon payments divided by the face value measured in bps.
Coupon type	Dummy variable for floating coupon bonds, which are benchmarked against STIBOR. The benchmark for the dummy is fixed coupon bonds that pay a fixed predetermined coupon rate throughout the maturity.
Time to maturity	The time between today and maturity date measured in years.
YTM at issuance	Time from issue date to maturity date measured in years.
Duration	How long it takes to receive the bonds true cost, measures in years.
Industry	Dummy variable for the bond issuers sector. Real estate, industrial, financial and utility bonds are benchmarked against municipal bonds.

5. Results and Analysis

5.1 Green Bond liquidity

Table 2 shows the descriptive statistics of the yield spread and difference in bid-ask spreads i.e. the difference in liquidity between the green and conventional bonds. Note that both the yield spread and the difference in bid ask spreads are expressed in basis points (bps). In the full sample and municipal bond sample the yield spread and difference in liquidity are different from zero and positive with a 95% confidence interval. This means that the bonds in the full sample and municipal bonds sample pay a higher yield and are less liquid than their conventional counterparts on average. In the corporate bond sample, the yield spread and difference in liquidity are different from zero and negative with a 95% confidence interval indicating that the bonds in the corporate bond sample pay a lower yield and are more liquid than their conventional counterparts on average. Thus, our prediction of that Swedish SEK green bonds are on average more liquid than conventional counterparts shows to be true for the corporate bond sample only. The corporate bond sample is therefore the only of our samples that agrees with recent findings of green bonds being more liquid than conventional bonds by, for example, Bachelet et al. (2019) and Wulandari et al. (2017). The liquidity of the full sample and municipal bond sample, in contrast, might still be affected by the relatively small size of the green bond market or a buy and hold strategy. The descriptive statistics of the yield spread and the difference in bid ask spread between the green and conventional bonds for the full sample, the corporate bonds and the municipal bonds are summarized in Table 2.

Table 2: Descriptive statistics of yield spread and Δbidask. The table below presents the number of observations, mean, standard deviation, and 95% confidence interval measured in bps of the yield spread and Δbidask for the full sample, corporate bonds and municipal bonds.

VARIABLES	Obs.	Mean	Std. Err.	Std. Dev.	95% Conf. Interval	
Full sample						
Yield spread	1,816	0.598	0.238	10.14	0.131	1.065
Δbidask	1,816	0.913	0.163	6.94	0.594	1.232
Coporate Bonds						
Yield spread	1,198	-0.869	0.276	9.55	-1.41	-0.328
Δbidask	1,198	-0.391	0.172	5.96	-0.729	-0.054
Municipal Bonds						
Yield spread	618	3.442	0.428	10.644	2.601	4.283
Δbidask	618	3.442	0.32	7.956	2.814	4.066

Source: Bloomberg

Table 3: OLS regressions of yield spread controlled for difference in liquidity. The table below displays the regressions where the yield spread is controlled for the difference in liquidity between the green bonds and their conventional counterparts.

	Dependent Variable: Yield Spread		
	(1)	(2)	(3)
VARIABLES	Full sample	Corporate Bonds	Municipal Bonds
Δbidask	0.526***	0.601*	0.353***
	(0.170)	(0.347)	(0.0953)
Constant	0.118	-0.634	2.228
	(0.763)	(0.848)	(1.640)
Observations	1,816	1,198	618
R-squared	0.130	0.140	0.069

Clustered (at the bond issue level) standard errors in parentheses
*** $p<0.01$, ** $p<0.05$, * $p<0.1$

The regressions in Table 3 show the results from the model by Zerbib (2019). The coefficient of Δbidask is positive and significant in all three samples implying that our sample of Swedish SEK green bonds compensate for lower liquidity. Thus, the null hypothesis that Swedish SEK green bonds do not compensate for liquidity can be rejected. The positive correlation indicates that the greater difference between a green and conventional bond's liquidity is compensated by a greater green bond yield, which is in line with the findings of, for example, Wulandari et al. (2017).

Table 4: OLS regressions of yield spread controlled for difference in liquidity, issue amount and coupon rate. The table below displays the regressions where the yield spread is controlled for difference in liquidity as well as difference in issue amount and difference in coupon rate.

Dependent Variable: Yield Spread			
	(1)	(2)	(3)
VARIABLES	Full Sample	Corporate Bonds	Municipal Bonds
Δbidask	0.552***	0.612*	0.345**
	(0.176)	(0.328)	(0.149)
Δissue amount	0.00380**	0.00451	0.00530**
	(0.00183)	(0.0159)	(0.00240)
Δcoupon rate	0.261	1.117	-0.999
	(1.227)	(1.733)	(1.823)
Constant	0.346	-0.558	2.883*
	(0.727)	(0.857)	(1.540)
Observations	1,816	1,198	618
R-squared	0.155	0.147	0.164

Clustered (at the bond issue level) standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The second regression with extra control variables for difference in issue amount and coupon rate is displayed in Table 4. Like the first regression, the Δbidask coefficient shows a positive correlation against the yield spread and is also significant in all three samples. Thus, the results of the second regression also rejects the null of the first hypothesis. Altogether, the results in table 3 and 4 counters the findings of Veys (2010) research in the Sterling bond market and suggest that Swedish SEK green bonds do compensate for lower liquidity in line with the liquidity premium theory. The extra control variable for coupon rate is insignificant in all three samples, suggesting that the difference in coupon rate does not have a statistically significant impact on the yield spread. The extra control variable for issue amount is significant in the full sample as well as the municipal bond sample suggesting that more differences than just the liquidity should be accounted for in order to retrieve a "true" green bond premium.

5.2 The green bond premium

To retrieve the green bond premium, differences between the green and conventional bonds need to be controlled for in the yield spread. The average green bond premium is represented by the constant in the regressions from Table 3 and Table 4, i.e., it is the average yield spread after controlling for the differences between the green and conventional bonds (controlling for liquidity differences only in Table 3 and for differences in issue amount and coupon rate additionally in Table 4). The regressions in Table 3, which follow the model of Zerbib (2019), show no significance of the constant in any of the samples. Thus, based on these regressions we cannot find any statistically significant green bond premium and therefore cannot determine whether there is a green preference for Swedish SEK green bonds or not. The output from the second regression model with extra control variables in Table 4 neither have significant constants in the full sample and the corporate bond sample. Thus, we cannot determine whether or not there is a Swedish green preference for these samples of bonds either. However, the output of the second regression model in table 4 shows a significant constant in the municipal bond sample. The results suggest an average green bond premium of 2.883 bps on the 10% significance level for Swedish SEK municipal bonds. The positive green bond premium suggest that investors require a higher yield for investing in green bonds than what they require for investing in a conventional equal counterpart. However, because this premium is only significant in one sample we do not consider it to be enough evidence to definitely say that Swedish SEK green municipal bonds carry a positive green bond premium of exactly 2.883 bps. This result should rather be seen as an indication of that there are no green preference for Swedish SEK municipal green bonds.

5.3 Green bond premium determinants

Table 5: OLS regression of the green bond premium. The table below displays the regressions where the green bond premiums are regressed against bond yield determinants and industry.

VARIABLES	(1) Premium1	(2) Premium2
Issue amount	-0.0362***	-0.0206**
	(0.00954)	(0.0101)
Coupon	-0.235	-0.343
	(1.585)	(1.545)
Floating	0.668	0.250
	(2.050)	(2.003)
Time to maturity	0.112***	0.111***
	(0.0414)	(0.0413)
YTM at issuance	-0.399	-0.614
	(0.723)	(0.732)
Duration	1.499***	1.334**
	(0.560)	(0.540)
Utilities	3.936***	2.937**
	(1.183)	(1.291)
Financial	0.299	-0.899
	(1.905)	(1.951)
Industrial	-10.32***	-10.38***
	(2.788)	(2.787)
Real estate	-4.542**	-4.898**
	(2.011)	(2.020)
Constant	0.945	1.972
	(4.722)	(4.689)
Observations	1,816	1,816
R-squared	0.161	0.129

Clustered (at the bond issue level) standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The individual green bond premium can be measured as part of the yield spread (green bond yield minus the yield of the matched conventional bond) that is unexplained by the differences in liquidity and the other controls used in Table 4, i.e., it is the sum of the constant and the regression residuals. We have two different individual premium estimates; one using the regression in the first column of Table 3 (labelled as Premium 1) and the other using the regression in the first column of Table 4 (labelled as Premium 2). Table 5 displays the results when the individual green bond premium is regressed against the green bond Issue amount, Coupon rate, Time to maturity, Macaulay Duration, Time from issue date to maturity (YTM at issuance) and dummies for whether the bond is Floating or not and what industry the bond is associated with. As it can be seen by comparing the two columns of Table 5, the results are not too sensitive to using Premium 1 or Premium 2 as the dependent variable.

We can observe that the regression outputs display a significant and negative β coefficient for the green bonds issue amount at 1% significance level excluding the control variables for difference in issue amount and coupon and at 5% significance level when including the controls, indicating slightly inflated results in the first column. The negative β indicates a lower green bond premium for higher issue amounts. In agreement with Veys (2010) research, lower issue amounts are often associated with lower demand and therefore lower liquidity, which generally accounts for a higher yield requirement. The reverse relationship is generally valid for higher issue amount, where the demand is higher and therefore more liquid, hence a lower required yield amongst bond investors. The next independent variable of the regressions in Table 5 is the coupon rate. The average coupon rate for the full green bond sample is 88,99 bps. The coupon rate is strongly related to the creditworthiness and stability of cash flows of the company, institute or municipality. The average coupon rate for the highest rated AAA bonds in the sample is 53,18 bps and all these are issued by a Swedish municipality. Whilst for the lowest rated BBB+ bonds, which are issued by either utilities corporates or industrial corporates, carry an average coupon rate of 120,92 bps. In regards to the theoretical framework, we would expect that the coupon rate would display a positive relation to the premium, i.e. the higher implied credit risk the higher green premium, supporting the hypothesis regarding on how credit risk might affect the green bond premium. Unexpectedly, the β coefficient in the regression analysis displays a negative relationship between the coupon rate and the green bond premium, however the coefficient is not significant, hence no relationship can be interpreted regarding the effect of coupon rate on the premium.

The bond sample consists of both fixed and floating coupon bonds, and the dummy variable *"floating"* is included in order to estimate a potential difference in effect to the green bond premium between the two coupon types. The key risk with fixed coupon bonds is the underlying interest risk, where increasing market rates cause fixed rate bonds being less valuable. However, floating coupon bonds are benchmarked against a short-term rate, 3M STIBOR throughout our sample, which results in a higher value of the bond when interest rates rise. On the contrary, Swedish interest rates have decreased since 2012, implying a negative effect on floating bond returns. We would therefore possibly expect a positive coefficient for the variable *"floating" a*s an effect of the previous dovish interest rate climate in Sweden covering the whole-time interval in our SEK green bond sample. However, the results display a positive but not significant β coefficient on the variable floating, hence no conclusions can be drawn from the bond sample on the effect of the difference in coupon type on the green bond premium.

The regression results in Table 5 also show a significant and slightly positive relationship between the time left to maturity and the green bond premium, implying that the green bond premium is higher for the bonds longer time to maturity left. This relates to Hicks liquidity premium theory and how long maturity bonds are less liquid than short maturity bonds due to the lower capital certainty together with exposure to systematic risk for a longer period of time. Fixed income investors in SEK green bonds seem to require a higher green bond premium the longer time to maturity is left. Hence, the positive beta coefficient indicates a positive correlation between the green bond premium and the term premium discussed by Cox et al. (1985) where the theory of term premium refers to the additional required yield for investing in long maturity bonds in order to compensate for the higher capital uncertainty. Cox et al. (1985) further state that term premium increases with time to maturity but at a diminishing rate. Furthermore, the variable yield to maturity at issuance (YTM at issuance) were regressed on the green bond premium as well, in order to investigate a potential presence of any maturity preferences amongst bond investors. The vast majority of our SEK green bonds in our sample consists of bonds with approximately 4Y or 5Y maturity with an average of 4,5 years throughout the sample, indicating a potential investor-driven demand for this category of maturities. Buying longer maturity green bonds could might facilitate for bond investors to maintain certain required green quotas or sustainable investment ratios in their fixed income portfolios. On the contrary, the variable YTM at issuance, i.e. years from the issue date to maturity depicts a slight negative relation to the green bond premium, however, this variable is not statistically significant and conclusions can therefore not be made.

As previously stated in the theory section, the time to maturity is highly related to the bond duration, and the duration reasonably depicts a positive and significant relation to the green bond premium as well. The β coefficient is slightly higher when excluding the control variables and is estimated at a 1% significance level, and slightly lower when including the controls and estimated at a 5% significance level. The positive β coefficient for the Macaulay duration indicates a higher green bond premium as duration increases. The Macaulay duration is a risk measurement of how long it takes for an investor to regain the bonds actual cost, where a higher duration indicates higher implied risk associated with the investment. The regression depicts that for higher duration bonds, investors require a higher green bond premium in order to take on increased interest rate risk in green bonds. The level of duration is highly connected to the years to maturity and the term premium and as discussed by Cox et al. (1985), the capital certainty is higher with shorter maturity and lower duration on bonds which also implies a lower term premium.

In line with the theoretical background, we can observe that traditional bond yield determinants have a slight effect on the green bond premium. The results from our sample thus suggest that Swedish green bond yield seems to be affected in line with traditional bond yield theory presented in section 2.

Table 6: Summary statistics by industries. The table below presents the number of observations, mean, standard deviation, and min and max value of the green bond yield and yield spread measured in bps for each industry included in the full sample.

VARIABLES	Obs.	Mean	Std. Dev.	Min	Max
Real estate					
Green bond yield	800	31.5	44.07	-35	230.1
Yield spread	800	-1.24	10.08	-41.2	37.3
Industrial					
Green bond yield	158	-0.869	9.55	-1.41	-0.328
Yield spread	158	-0.391	5.96	-0.729	-0.054
Banks & financial inst.					
Green bond yield	200	35.38	29.17	-16.6	109.1
Yield spread	200	2.76	5.93	-18.1	31.1
Utilities					
Green bond yield	40	33.15	26.53	-8	81.2
Yield spread	40	7.27	2.63	-1.9	14.7
Municipal					
Green bond yield	618	-2.25	37.55	-59.6	148.8
Yield spread	618	3.44	10.64	-26.7	79.3

Source: Bloomberg

The green bond sample of 101 bonds can be divided into the 5 different sectors illustrated in Table 6. When inspecting the green bond premium within the different industry sectors, we can observe that for the high credit quality real estate industry, with bonds carrying AA+, A or A- rating in the sample, the results exhibit a negative β coefficient on the green bond premium estimated with a 5% significance level. Whilst for the lower rated utilities industry the β coefficient exhibits a positive sign and is significant at a 5 % significance level when the controls Δ*issue amount* and Δ*coupon rate* are included in the green bond premium. An even higher β coefficient at a 1% significance level is found in sample without the extra control variables indicating slightly inflated results when excluding this information. Nevertheless, both regressions show indication of a higher green bond premium within the Swedish utilities sector. In general, the corporate green bonds carry a lower green bond premium than the municipal bonds, except for the utilities sector in our bond sample. Utilities is the only one of the industry sectors displaying a significant and positive β coefficient suggesting that utilities bonds carry a higher green bond premium than the benchmark, which is municipal bonds. In agreement with Veys (2010) the utilities sector carry higher credit risk in our SEK bond sample as well, with a BBB+ rating from S&P, which constitutes the lowest credit rating amongst the companies in our bond sample. The average green bond yield within the utilities industry and real estate industry is 33.15bps and 31.15bps respectively, and the yield spread between the green and conventional utilities bonds is on average 7.27 bps and -1.24 bps for the real estate companies. Thus, supporting the regression results of a higher displayed green bond premium for the utilities bonds. In accordance to the theory of the default risk premium, investors seem to require a higher yield for taking on higher credit risk and invest in utilities bonds, particularly green utilities bonds where the risk is presumed to be higher solely for the bond being green. Furthermore, the regression output together with the observed negative yield spread for real estate bonds indicates a green preference since investors are willing to accept a slightly lower yield for green real estate bonds with the same credit profile and bond characteristics as their green matched counterpart. Noteworthy is that more than half of the SEK green real estate bonds are non-rated, and the rated bonds either carry an A, A- or AA+ rating and thus indicating a lower underlying credit risk premium together with a lower observed green bond premium within real estate bonds.

According to previous studies regarding sector analysis on green bonds, Zerbib (2019), found that bonds issued by financial institutions display a more negative green bond premium in comparison to bonds issued by municipalities and utility companies. Thus, we would conceivably also expect a slight negative effect on the green bond premium, due to a similar credit risk profile as the real estate companies. However, the regression output depicts a positive β when excluding the control variables in the green bond premium and exhibits a negative β when the controls are included in the estimation of the premium. Nevertheless, none of these β coefficients are statistically significant, hence no conclusions on the effect of financial institutions on the green premium can be drawn from this green bond sample. Furthermore, when focusing on the industrial sector, we can observe the most evident negative β coefficient, estimated with a 1% significance, on the green bond premium signaling that investors seem to be prepared to receive a slightly lower yield for investing sustainable within this sector. Consequently, the regression output indicates that it is slightly cheaper from the Swedish issuers perspective to issue green industrial and green real estate bonds than non-green industrial and real estate bonds denominated in SEK. Hence, bond investors seem to be willing to receive a slightly lower yield for investing sustainably within these two sectors and thus indicating an investor-driven demand for sustainable investments.

In conclusion, the underlying credit risk and rating within each of these industries seem to have an effect on the green bond premium. The overall regression output results in a rejection of the null of the third hypothesis on how sector-specific risk together with the underlying credit risk discussed by Brigham and Daves (2007), does not determine the level of green bond premium. Moreover, utilities bonds carry higher credit risk and have the lowest credit scores in our SEK green bond sample and are, as previously mentioned, the only sector displaying a significant and positive β coefficient on the green bond premium for our SEK sample. The underlying sector risk, which is highly related to the credit risk and rating, is the primary determinant for the Swedish SEK green bond premium.

6. Conclusion and further research

6.1 Conclusion

The purpose of this study was to outline whether the Swedish SEK green bond yields differs from Swedish SEK conventional bond yields. Three research questions were studied in order to fulfill the purpose:

-*Do Swedish SEK green bonds compensate for liquidity risk?*

-*Is there a Swedish green preference?*

-*What determines the green bond premium?*

By matching 101 green and conventional equal counterparts and analyzing their yield spread we have been able to find some answers and draw conclusions on the questions asked.

The positive correlation between the yield spread and difference in liquidity suggest that Swedish SEK green bonds compensate for liquidity risk. Hence, the answer to the first research question is that the samples in our study shows evidence of that Swedish SEK green bonds compensate for liquidity risk. When looking at the difference in liquidity, we can also conclude that Swedish SEK green corporate bonds seem to be more liquid than their conventional counterparts.

A positive green bond premium of 2.883 bps at the 10% level of significance was found in the municipal bond sample when regressing the yield spread against difference in liquidity, coupon rate and issue amount. However, because this green bond premium was only significant in one of the regression models and at 10% significance level, we do not consider it to be enough evidence to draw a definite conclusion on whether or not there is a Swedish green preference. Thus, the research question of whether there is a Swedish green preference could not be answered.

The answer to the third research question was found in the regression analysis of the green bond premiums collected from the first regression step. The regression output showed that the predominant determinants of the green bond premium seem to be whether the bond is a corporate or municipal bond and what type of industry the bond is associated with. Thus, we conclude that the underlying credit risk and rating within each sector seem to have the largest effect on the Swedish SEK green bond premium.

6.2 Proposition for further research

As a result of the green bond market being a relatively young fixed income category, not much academic research has been performed within the field. Particularly not the in Swedish SEK green bond market. A proposition for further research would be to examine the Swedish green bond market when a larger amount of Swedish SEK green bonds has been issued in order to obtain a sufficient sample size to potentially achieve more significant effects when estimating the green bond premium. An extension to this study would also be to investigate the investor preferences and risk perspective through a qualitative study, to estimate the demand in secondary markets in order to obtain a more forward-looking perspective of the Swedish SEK green bond yields.

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Appendix

List of matched green and conventional bonds

Green	ISIN	Amount issued million SEK	Coupon type	Issue date	Maturity date
1	SE0009779465	500	Fixed	3/27/2017	27/03/2020
0	SE0010494765	500	Fixed	26/10/2017	26/10/2020
1	SE0011088756	500	Fixed	19/04/2018	19/04/2021
0	SE0010494765	500	Fixed	26/10/2017	26/10/2020
1	SE0011425883	300	Fixed	06/09/2018	06/09/2021
0	SE0010494765	500	Fixed	26/10/2017	26/10/2020
1	SE0009161607	650	Floating	04/10/2016	04/10/2021
0	SE0010599332	200	Floating	11/09/2018	11/10/2021
1	SE0009161615	350	Fixed	04/10/2016	04/10/2021
0	SE0010832964	300	Fixed	06/09/2018	06/09/2021
1	XS1073488675	310	Fixed	03/06/2014	03/06/2020
0	XS0471612589	100	Fixed	04/12/2009	04/12/2019
1	XS1627778316	1200	Fixed	14/06/2017	14/06/2023
0	XS1791485953	400	Fixed	16/03/2018	16/03/2023
1	XS1073521988	1500	Floating	03/06/2014	03/06/2020
0	XS1200105226	2000	Floating	10/03/2015	10/03/2020
1	XS0976166719	250	Fixed	03/10/2013	03/10/2019
0	XS0471612589	100	Fixed	04/12/2009	04/12/2019
1	XS1253847815	1050	Fixed	30/06/2015	30/06/2021
0	XS1405911576	1350	Fixed	10/05/2016	10/05/2021
1	XS1433082861	1000	Fixed	15/06/2016	15/06/2022
0	XS1578283712	3000	Fixed	14/03/2017	16/03/2022
1	XS0976165828	250	Floating	03/10/2013	03/10/2019
0	XS1287810300	1500	Floating	09/09/2015	09/09/2019
1	SE0009947500	750	Floating	18/05/2017	18/05/2022
0	SE0009161094	550	Floating	28/09/2016	28/09/2021
1	XS1732403925	650	Floating	07/12/2017	07/03/2022
0	XS1622283742	500	Floating	26/05/2017	15/03/2023
1	SE0009190069	600	Floating	13/10/2016	13/10/2021
0	SE0009858129	250	Floating	25/04/2017	26/04/2021
1	SE0010599035	500	Floating	15/12/2017	15/12/2022
0	SE0009806243	600	Floating	11/04/2017	11/04/2022
1	SE0006371316	550	Floating	16/10/2014	16/10/2019
0	SE0005991668	250	Floating	23/05/2014	23/05/2019
1	SE0009164213	500	Floating	06/10/2016	06/10/2021
0	SE0008374870	500	Floating	25/05/2016	25/05/2021
1	SE0010599027	800	Floating	29/11/2017	29/11/2022

0	SE0010469023	150	Floating	19/10/2017	19/10/2022
1	SE0009357338	250	Floating	30/11/2016	30/11/2021
0	SE0008102974	450	Floating	02/03/2016	02/06/2021
1	SE0009357320	500	Fixed	30/11/2016	30/11/2021
0	SE0007784285	100	Fixed	09/12/2015	09/12/2020
1	XS1051134556	500	Fixed	02/04/2014	02/04/2019
0	XS1243996706	900	Fixed	10/06/2015	10/06/2019
1	XS1050940516	1000	Floating	02/04/2014	02/04/2019
0	XS1243997852	600	Floating	10/06/2015	10/06/2019
1	SE0010947143	500	Fixed	28/02/2018	28/02/2023
0	SE0011062959	300	Fixed	30/08/2018	30/08/2023
1	SE0011062793	500	Floating	17/04/2018	17/04/2023
0	SE0005397155	200	Floating	19/09/2013	19/09/2023
1	SE0011062801	1000	Fixed	17/04/2018	17/04/2023
0	SE0010440966	100	Fixed	29/09/2017	29/09/2022
1	SE0010599407	100	Floating	15/11/2018	15/11/2021
0	SE0009241680	200	Floating	25/10/2016	25/10/2021
1	SE0010599290	150	Floating	12/06/2018	12/06/2020
0	SE0006425641	200	Floating	30/10/2014	30/10/2019
1	XS1897258098	3000	Fixed	23/10/2018	01/06/2023
0	SE0009662943	26985	Fixed	22/02/2017	22/02/2023
1	XS1814404577	3000	Fixed	30/04/2018	15/12/2021
0	SE0006995064	33759	Fixed	23/04/2015	15/09/2021
1	XS1508534861	5000	Fixed	25/10/2016	05/05/2020
0	SE0005705621	31867	Fixed	26/02/2014	01/12/2020
1	SE0010599100	1250	Floating	21/03/2018	21/03/2022
0	SE0010442707	1000	Floating	11/10/2017	11/10/2021
1	SE0010599118	1250	Fixed	21/03/2018	21/03/2022
0	SE0010442715	350	Fixed	11/10/2017	11/10/2021
1	XS1824244807	5250	Fixed	25/05/2018	25/05/2023
0	SE0005768967	1110	Fixed	27/02/2014	13/11/2023
1	SE0009190481	775	Floating	17/10/2016	18/10/2021
0	SE0007815352	500	Floating	17/12/2015	17/12/2020
1	SE0008294805	250	Floating	29/04/2016	29/04/2019
0	SE0008348791	300	Floating	20/05/2016	20/05/2019
1	SE0009345622	350	Floating	22/11/2016	22/02/2022
0	SE0009189772	600	Floating	11/10/2016	11/10/2021
1	SE0010468900	250	Floating	19/10/2017	19/10/2022
0	SE0010832212	250	Floating	01/02/2018	01/02/2023
1	SE0009345630	150	Fixed	22/11/2016	22/02/2022
0	SE0011062918	376	Fixed	12/07/2018	12/01/2022

1	SE0010469031	450	Fixed	19/10/2017	19/10/2022
0	SE0011062918	376	Fixed	12/07/2018	12/01/2022
1	SE0006510186	200	Floating	02/12/2014	02/12/2016
0	SE0006370789	250	Floating	13/10/2014	13/10/2016
1	SE0006510681	250	Floating	05/12/2014	05/06/2017
0	SE0006425997	250	Floating	03/11/2014	03/11/2017
1	SE0007073895	400	Floating	07/05/2015	07/05/2018
0	SE0006510723	500	Floating	05/12/2014	05/06/2018
1	SE0007073903	350	Fixed	07/05/2015	07/05/2018
0	SE0006509915	300	Fixed	01/12/2014	01/12/2017
1	XS1436728916	1000	Floating	23/06/2016	23/06/2021
0	XS1799639908	2360	Floating	29/03/2018	29/03/2021
1	XS1697766951	750	Floating	11/10/2017	11/10/2022
0	XS1626072356	1500	Floating	08/06/2017	08/06/2022
1	XS1697577556	1000	Fixed	11/10/2017	11/10/2022
0	XS1626072273	1500	Fixed	08/06/2017	08/06/2022
1	XS1436518606	1000	Fixed	23/06/2016	23/06/2021
0	XS1397032431	300	Fixed	19/04/2016	19/04/2021
1	SE0010600262	500	Fixed	28/11/2017	28/11/2022
0	SE0010297069	350	Fixed	29/08/2017	29/08/2022
1	SE0010600270	750	Fixed	28/11/2017	28/11/2024
0	SE0004722510	130	Fixed	25/06/2012	25/06/2024
1	NO0010823362	800	Floating	01/06/2018	01/06/2023
0	NO0010766157	200	Floating	01/06/2016	01/06/2022
1	SE0007075122	1000	Floating	18/05/2015	18/05/2021
0	SE0007525951	600	Floating	17/09/2015	17/09/2020
1	XS1069349089	230	Fixed	19/05/2014	19/05/2020
0	XS1820078621	200	Fixed	14/05/2018	14/05/2020
1	XS1626936626	2000	Fixed	09/06/2017	09/06/2022
0	XS1872367203	500	Fixed	30/08/2018	30/08/2021
1	XS1915003005	2500	Fixed	26/11/2018	30/09/2021
0	XS1872367203	500	Fixed	30/08/2018	30/08/2021
1	XS1069348941	870	Floating	19/05/2014	19/05/2020
0	XS1291604111	750	Floating	15/09/2015	15/09/2020
1	XS1239582684	300	Floating	28/05/2015	28/05/2021
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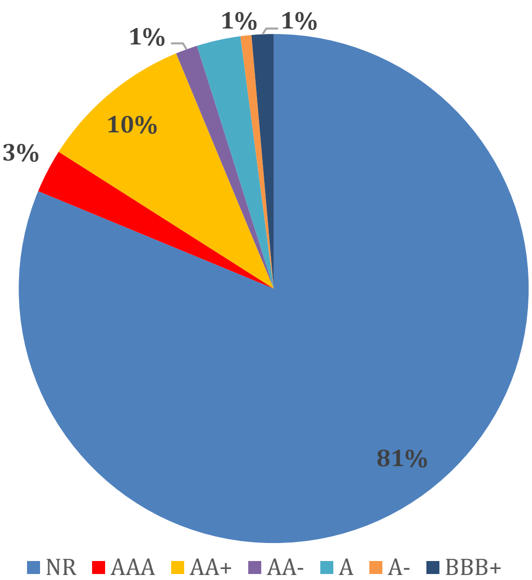
1	XS1420355023	1500	Fixed	27/05/2016	27/09/2021
0	XS1872367203	500	Fixed	30/08/2018	30/08/2021
1	XS1239582502	1500	Fixed	28/05/2015	28/05/2021
0	XS1872367203	500	Fixed	30/08/2018	30/08/2021
1	SE0010414698	550	Floating	26/09/2017	26/09/2022

0	SE0004452837	400	Floating	14/02/2012	14/02/2022
1	SE0008092787	300	Floating	01/03/2016	01/03/2021
0	SE0004452837	400	Floating	14/02/2012	14/02/2022
1	SE0008092795	700	Fixed	01/03/2016	01/03/2021
0	SE0005307410	150	Fixed	12/07/2013	12/07/2021
1	SE0009241656	500	Fixed	31/10/2016	28/02/2019
0	SE0009579774	500	Fixed	06/02/2017	06/02/2019
1	SE0011642115	600	Fixed	07/09/2018	07/09/2020
0	SE0011088830	534	Fixed	31/05/2018	31/05/2020
1	SE0010547828	950	Fixed	20/11/2017	20/11/2019
0	SE0010325530	580	Fixed	25/09/2017	25/09/2019
1	SE0009580160	300	Floating	07/02/2017	29/05/2020
0	SE0006851341	889	Floating	09/03/2015	09/03/2020
1	SE0011642123	320	Floating	07/09/2018	07/09/2020
0	SE0006851341	889	Floating	09/03/2015	09/03/2020
1	SE0008964415	920	Floating	07/09/2016	07/09/2018
0	SE0008374524	652	Floating	31/05/2016	31/05/2018
1	SE0007730247	1126	Floating	20/11/2015	20/11/2017
0	SE0006851325	275	Floating	09/03/2015	09/03/2017
1	SE0009346422	700	Floating	01/12/2016	03/12/2018
0	SE0008374524	652	Floating	31/05/2016	31/05/2018
1	SE0007491014	500	Floating	10/09/2015	10/09/2020
0	SE0008092803	300	Floating	03/03/2016	03/03/2020
1	SE0010297424	200	Floating	31/08/2017	31/08/2020
0	SE0007704614	200	Floating	10/11/2015	10/11/2020
1	SE0010832899	300	Fixed	20/06/2018	22/06/2020
0	SE0010297259	200	Fixed	29/08/2017	29/08/2022
1	SE0009607013	490	Fixed	14/02/2017	28/08/2019
0	SE0009580186	250	Fixed	31/01/2017	31/07/2019
1	SE0011425834	700	Fixed	30/08/2018	30/08/2021
0	SE0008963920	515	Fixed	29/08/2016	15/12/2021
1	SE0009983810	830	Fixed	24/05/2017	24/05/2022
0	SE0010297259	200	Fixed	29/08/2017	29/08/2022
1	SE0005798824	750	Floating	19/03/2014	19/03/2019
0	SE0006261079	510	Floating	12/09/2014	12/09/2019
1	SE0010833020	200	Fixed	14/09/2018	14/09/2022
0	SE0010297259	200	Fixed	29/08/2017	29/08/2022
1	SE0006452553	500	Floating	18/11/2014	18/11/2019
0	SE0006261079	510	Floating	12/09/2014	12/09/2019
1	SE0009983802	600	Floating	24/05/2017	24/05/2022
0	SE0009189541	200	Floating	11/10/2016	11/10/2021

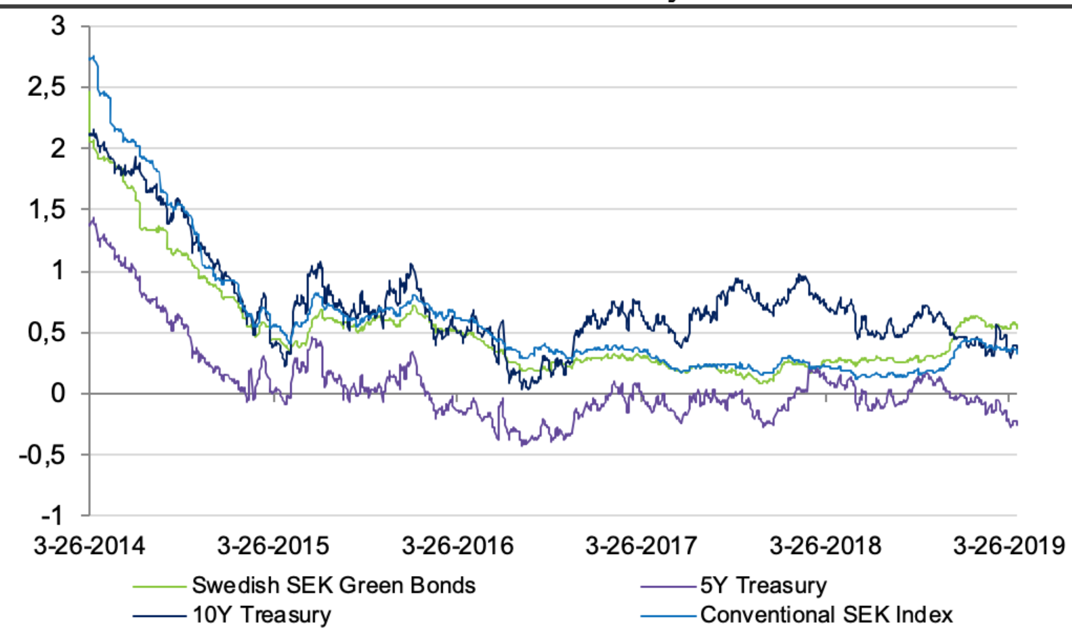
1	SE0005798816	500	Fixed	19/03/2014	19/03/2019
0	SE0009580186	250	Fixed	31/01/2017	31/07/2019
1	SE0010948661	500	Fixed	05/03/2018	05/03/2021
0	SE0008963920	515	Fixed	29/08/2016	15/12/2021
1	SE0010832949	100	Floating	30/08/2018	30/08/2021
0	SE0009189541	200	Floating	11/10/2016	11/10/2021
1	SE0011062298	450	Fixed	23/03/2018	23/02/2021
0	SE0008963920	515	Fixed	29/08/2016	15/12/2021
1	XS1917357573	300	Floating	30/11/2018	15/02/2022
0	SE0009189541	200	Floating	11/10/2016	11/10/2021
1	SE0009190606	470	Fixed	18/10/2016	18/10/2021
0	SE0008963920	515	Fixed	29/08/2016	15/12/2021
1	SE0007666136	417	Fixed	22/10/2015	22/10/2020
0	SE0007704978	1315	Fixed	10/11/2015	10/11/2020
1	SE0009190614	400	Floating	18/10/2016	18/10/2021
0	SE0009189541	200	Floating	11/10/2016	11/10/2021
1	SE0010442699	150	Fixed	13/10/2017	14/04/2020
0	SE0007704978	1315	Fixed	10/11/2015	10/11/2020
1	SE0009241425	1000	Floating	24/10/2016	24/04/2019
0	SE0006261079	510	Floating	12/09/2014	12/09/2019
1	SE0011062967	550	Floating	30/08/2018	30/06/2021
0	SE0009189541	200	Floating	11/10/2016	11/10/2021
1	SE0010599084	1040	Floating	26/01/2018	26/01/2021
0	SE0009189541	200	Floating	11/10/2016	11/10/2021
1	SE0007413299	156	Floating	21/08/2015	21/08/2018
0	SE0005218971	350	Floating	28/05/2013	28/05/2018
1	SE0007666128	333	Floating	22/10/2015	22/10/2020
0	SE0007704614	200	Floating	10/11/2015	10/11/2020
1	SE0006800975	650	Fixed	20/02/2015	20/02/2018
0	SE0006758751	100	Fixed	03/02/2015	02/02/2018
1	SE0005932266	1000	Floating	24/04/2014	24/10/2016
0	SE0005703477	1016	Floating	03/02/2014	12/08/2016
1	SE0008241509	550	Floating	07/04/2016	07/06/2018
0	SE0006758751	100	Fixed	03/02/2015	02/02/2018
1	SE0010599092	200	Fixed	08/03/2018	08/03/2023
0	SE0010298034	200	Fixed	31/08/2017	31/08/2022
1	SE0009921950	700	Floating	16/05/2017	16/05/2022
0	SE0010101915	700	Floating	27/06/2017	27/09/2022
1	SE0008400402	400	Floating	30/05/2016	30/05/2018
0	SE0005797065	400	Floating	05/06/2014	05/06/2017

Swedish SEK Green Bond S&P Credit Rating distribution



Source: Bloomberg

Swedish SEK Green Bond Yields vs Matched non Green Swedish SEK Bond Yields In relation to Swedish Treasury Yields



Source: Bloomberg