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HOW DO A COMPANY'S ESG SCORES AFFECT THEIR GSS+ BOND YIELD TO
MATURITY?

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Abstract: This paper investigates the impact of Environmental, Social, and Governance (ESG) scores on the yield to maturity (YTM) of Green, Social, Sustainable, and Other Labelled (GSS+) bonds issued by companies in the S&P 500 index. Using a multi-linear regression model, the study reveals a statistically significant but negligible relationship between ESG scores and GSS+ bond YTM. The findings suggest that investors may not consider ESG scores when making investment decisions, pointing to a lack of value attributed to these scores. Additionally, the paper explores the effects of other variables, such as principal currency and ESG bond type, on bond yields, highlighting the need for further research in this evolving field.

Keywords: ESG Scores, Green Bonds, Sustainable Finance, Corporate Sustainability

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1. Introduction

The following paper provides insight into the effect of a company's Environmental, Social, and Governance (ESG) score on the yield to maturity (YTM) of their Green, Social, Sustainable and Other Labelled (GSS+) bonds. ESG refers to a set of standards by which stakeholders can measure an organisation's impact on their direct surroundings, through its three pillars: Environment, Social, and Governance (London Stock Exchange, 2022).

ESG investing grew out of the Socially Responsible Investing (SRI) framework (CFA Institute 2023). SRI focused on ethical judgments and negative screening to filter companies, whilst ESG integrated key criteria into traditional financial analysis, providing quantifiable metrics to investors. The term ESG first arose in a United Nation's Principals for Responsible Investment report in 2006, in which companies were required to incorporate ESG reporting criteria. The goal was to promote sustainable investments by committing capital to ESG issues. At the time, 63 investment companies committed 6.5tn USD in Assets Under Management (AUM) to incorporating ESG in their investment strategy. Since then, the commitment has risen to over 80tn USD in over 2450 companies (Betsy 2023). Nonetheless, issues persisted with regards to measuring companies' ESG performance, given the different intricacies affecting each business' individual working environment. In response, a framework consisting of a standardized set of 22 specific, quantifiable metrics was established at the World Economic Forum in 2020. The metrics are within the company's capabilities to report on and are aligned with the UN's 2030 Agenda for Sustainable Development. ESG ratings emerged from these framework designs, to serve an increasing demand from ESG investors for ESG data. Rating agencies collect and compile data from each pillar producing an ESG score with which investors can compare companies' ESG performance, effectiveness, and commitment (World Bank Group 2021).

In tandem with the rise of ESG, governments and corporates were looking for methods

to incentivise and finance ESG investing. A carbon tax was imposed on large corporates through cap-and-trade systems, whilst tax incentives and general consumer sentiment provided further motivation for companies to express their commitment to a sustainable future. More information with regards to the specific securities introduced to promote climate finance can be found in the *Theoretical Framework* section.

Amongst the newly introduced securities were green bonds. Green bonds refer to fixed income instruments that specifically include a “use of proceeds” clause stating that the funds will be used to fund projects with dedicated environmental benefits (Climate Bonds Initiative 2023). Green bonds were first issued in 2008 by the World Bank, as a response to a report published by the Intergovernmental Panel for Climate Change, linking human action to global warming (World Bank Group 2023). Since then, approximately 2.3tn USD of Green Bonds have been issued, of which 560bn USD in 2023 (Climate Bonds Initiative 2023). The following paper focuses specifically on companies in the S&P 500 index, with a total green bond issuance volume of approximately 53bn USD since 2016.

Literature has found that issuing green bonds is correlated with an improvement in the issuing firm’s environmental performance and can in certain cases generate cumulative abnormal return (CAR) for issuing firms in equities markets (Flammer 2021). Moreover, Maino (2022) shows that premiums for green bond issuers exist in the primary market due to consumer sentiment. Using an assumption that consumers trust reported ESG scores, and that higher ESG scores represent positive consumer sentiment with regards to a company’s potential ESG performance, this paper aims to find relationships between ESG scores and green bond YTMs to better understand how consumer sentiment influenced by ESG scores affects a company’s debt cost of capital.

This paper finds that for each unit increase in ESG score, there is a corresponding increase of 0.016% in predicted YTM, significant at any level. Given that ESG scores are

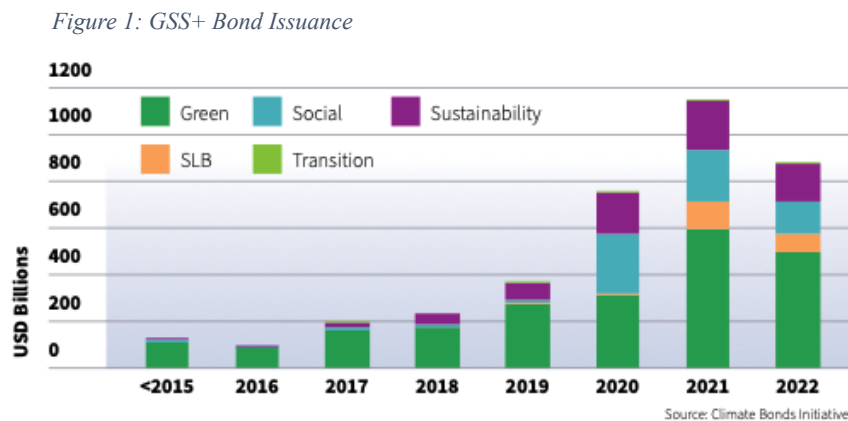
awarded on a scale of 0-100, 1.6% variation is expected across the whole ESG scoring scale. As a result, the effects of ESG scores on GSS+ Bonds are found to be negligible.

2. Literature Review

Since green bonds are fixed-income instruments, investors receive repayment through coupons until the principal is repaid at maturity. As a result, investors are exposed to the cashflow risks of the issuing company. Thus, in principle, green and non-green (conventional) bonds from the same issuer with the same maturity, structure, and coupon, should be priced the same.

Weber and Saravade (2019) state that oversubscription is common in both conventional and green bond investment grade markets. Moreover, investor demand in both bond markets is dependent on bond size, timing of issuance, time to maturity, credit quality, and price and supply in the market.

The Green, Social, Sustainable, and other labelled (GSS+) bond markets have grown significantly since inception, with 3.7tn USD in cumulative issuance to date (Figure 1). 2021 had the largest issuance volume to date, with 1.1tn USD. In 2022, 81% of the volumes were priced in EUR (42%), USD (29%) or CNY (10%). Moreover, supernational organisations such as the European Investment Bank (EIB) and World Bank were the largest individual issuers of green debt, at 115.9bn USD. The USA was the largest country source, whilst China produced the largest volume of green bonds (Climate Bonds Initiative, 2023).



Using the German Twin Bonds case study, which looks at a series of conventional and green German government bonds with identical characteristics, Maino (2022) finds that there is mispricing between equivalent conventional and green bonds. He shows that there is a ‘greenium’ (a pricing premium paid by investors to hold green bonds) ranging between 0.02% and 0.08% between the end of 2020 and 2021. Similarly, Ehlers and Packer (2017) find an average ‘greenium’ of 0.18% on 21 green bonds issued between 2014 and 2017. There is also 0.27% variation around the 0.18% average, showing that green bond pricing is subject to substantial uncertainty.

In trying to understand the source of green bond pricing variation, Maino (2022) compares the average mid-YTMs of green and conventional bonds across different bond durations and credit ratings. The results find differences between ‘greeniums’ depending on their credit rating levels. Maino suggests that differences in YTM are due to consumer preferences. Higher demand for green bonds in primary markets leads to oversubscribed issuances and therefore lower interest paid by issuers.

In a study on the US municipal green bonds market, Backer et al. (2018) find that there is an after-tax ‘greenium’ of 0.06%. Moreover, they find that the ‘greenium’ is two-to-three times higher if the bond is certified by a third-party. They also find that for each increase in credit rating, there is an average of 0.12% increase in ‘greenium’, increasing to 0.13% if the bond is Climate Bond Initiative (CBI) certified.

Overall, this literature suggests that differences in pricing between green and conventional bonds are not due to differences in the securities’ fundamentals, but due to consumer preferences in the primary market. Credit risk remains coupled with the issuer’s operations, implying therefore that green bonds with the same characteristics and issuer as a conventional bond share a similar risk profile (Maino 2022).

In the secondary market, Flammer (2021) and Larcker and Watts (2020) find that there

is on average no difference in pricing between green and conventional bonds. This suggests that there is no cost-of-capital incentive for green bond issuers.

Using event study methodology, Flammer (2021) finds in the ten days leading to a firm's first bond issuance, and the subsequent five days, firms generate an average cumulative abnormal return (CAR) of 0.49%. The CAR is significantly higher for certified green bonds (0.71%) and first-time green bond issuers (0.8%). Seasoned green bond issuers experience small and insignificant CARs. In addition, she finds that significant abnormal returns only occur in industries where companies are financially dependent on the natural environment.

On a firm level, Flammer (2021) finds that green bond issuers improve their environmental rating (using Thomson Reuters' ASSET4) and decrease their CO² emissions post-issuance. This supports her signalling argument, which states that green bond issuance may serve as a credible signal with regards to the company's commitment to the environment. Nonetheless, Flammer states that the relationship is not causal, and green bond issuance is likely too small to provide significant ecological improvements at firm level.

Based on the findings above, it is apparent that a consumer preference for green securities exists. Maino (2022) finds a 'greenium' in the primary green bonds market, whilst Flammer (2021) shows that a CAR exists for companies issuing green bonds. However, the relationship between a company's ESG rating, and their green bond YTM is unclear. If consumers trust reported ESG positive investments, then eco-conscious investors should prefer securities where the issuer has a comparatively high ESG rating. As such, demand for these securities should increase, affecting bond price and its associated YTM.

This paper contributes to the available literature by investigating whether investors on the secondary market are willing to forgo monetary rewards for more efficient and trustworthy ESG investments. Bond prices are predominantly affected by the security's fundamentals, however, evidence of consumer demand affecting green bond prices has been found in the

primary market. This paper expands on the research conducted by Maino (2022) and Flammer (2021), with the aim of further identifying market forces affecting green bond pricing in the secondary market. As such, the null hypothesis is that ESG ratings and green bond YTM have no linear relationship at a 5% significance level. Conversely, the alternative hypothesis, is that ESG ratings and green bonds have a linear relationship.

Results in this paper show that ESG scores have a negligible effect on GSS+ bond YTM. Though investors are eco-conscious, the ESG scores have no impact on their decision making, pointing towards a lack of value attributed to the ESG scores.

3. Theoretical Framework

The following section will discuss different forms of sustainable debt and expand on the ESG scoring framework used in this paper.

Sustainable debt can be assigned to two categories, activity-based or behaviour-based. Activity-based sustainable debt refers to investment into a project or business with an intended environmental or social outcome, for example, funding affordable housing or clean energy projects. Behaviour-based products link the loan's interest rate with a sustainability target such as reducing greenhouse gas emissions or reaching a workforce diversity quota. Within both product categories there are bonds and loans relating to different investment themes (Harvard Business School Online, 2023). Loans involve direct lending between a borrower and a lender, typically a financial institution, where the borrower receives a specified amount and agrees to repay with interest over a defined period. Bonds, on the other hand, represent debt securities issued by corporations or governments to multiple investors, who become bondholders and receive periodic interest payments along with the return of principal at maturity (ibid.). This paper will focus exclusively on bonds, as they are available to trade on the public secondary market, facilitating data availability.

Sustainability-linked (aka. KPI- or SDG-linked) bonds are the only type of behaviour-based

bond. They are linked to a climate or broader SDG goal. Progress with regards to a specific SDG or selected KPI will result in a decrease in the coupon rate from investors, and vice versa. This form of bond is particularly useful in cases where companies require encouragement to make sustainability commitments (ICMA 2023).

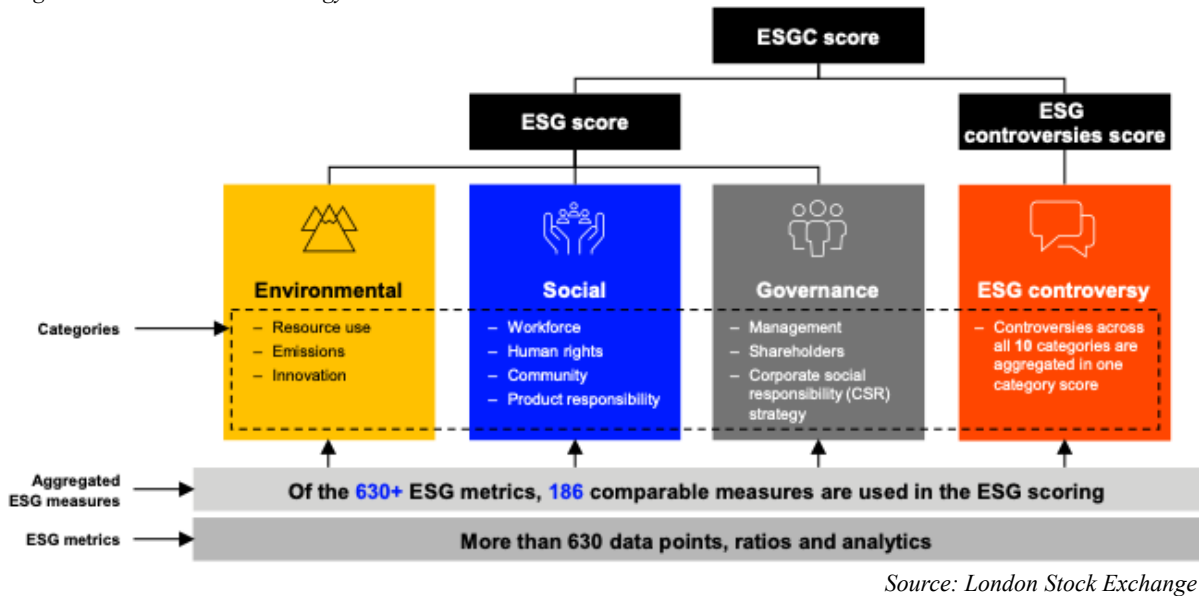
There are three types of activity-based sustainable bonds; green bonds, social bonds, and sustainability bonds. Green bonds exclusively finance new or existing projects that contribute towards a net-zero emissions economy and protect the environment (ICMA 2021). Examples of green bond projects include renewable energy, clean transportation, wastewater management, or green infrastructure. Social bonds require that positive social outcomes are achieved with the debt financing. Typical projects include food security and sustainable food systems, socioeconomic advancement, affordable housing, or COVID-19 relief (Pimco 2023). Sustainability bonds apply to projects whose scope applies to both green and social projects. To receive respective bond labelling, issuers must adhere to regulators' guidelines. Though this can be costly, literature has found that 'greeniums' exist for regulator aligned bonds, in contrast to self-labelled bonds (Flammer 2021). The dataset used throughout this paper will consist of both labelled and self-labelled bonds.

The London Stock Exchange's (LSEG) ESG ratings will be used throughout this paper. This database was chosen as it is one of the most comprehensive databases available, representing over 85% of the global market capitalisation. Moreover, it is integrated with the Refinitiv platform, facilitating data transfer and usage.

Figure 2 shows LSEG's scoring methodology. Due to unique circumstances affecting different industries, LSEG's scoring system is based on relative industry performance. Of the 630 data points that are collected, only 186 of the most comparable data points are used. This is to achieve higher levels of data standardisation, helping LSEG provide more directly comparable measurements for ESG performance. These are then grouped into the three pillars,

after which an ESG score is produced using an industry-unique weighting system.

Figure 2: ESG Score Methodology



4. Methodological Approach

The following section describes the methodological approach applied in this paper with regards to data collection, the dependent and independent variables, and the working assumptions.

4.1 Research Design

A correlational research design is used to find directional relationships between the independent and dependent variables. This approach is applied due to its favourable feasibility and more direct implications for reality. Moreover, this study seeks to identify patterns and trends arising from market data, rather than causal relationships. As such, the predictive value of the study is maintained by using readily available real time data, gathered from a reliable data marketplace.

A regression model will be used to test correlational effects. Eight independent variables will be used, of which seven are control variables, helping to improve the regression model's overall R^2 . As such, the regression's equation is:

$$YTM_i = \beta_0 + \beta_1 M_i + \beta_2 ID_i + \beta_3 C_i + \beta_4 ET_i + \beta_5 AI_i + \beta_6 D_i + \beta_7 ES_i + \beta_8 CR_i + \varepsilon$$

Where:

- YTM is Yield to Maturity for observation i
- M is Bond Maturity for observation i in date form;
- ID is Issuance Date for observation i in date form;
- C is Principal Currency for observation i , represented as a categorical dummy variable;
- ET is ESG Bond Type for observation i , represented as a categorical dummy variable;
- AI is Amount Issued for observation i in USD values;
- D is Macauley Duration for observation i in absolute terms;
- ES is ESG score for observation i , as directly reported by LSEG;
- CR is Credit Rating for observation i , represented as a categorical dummy variable.

β_0 represents the y-intercept, the expected value of the dependent variable when all independent variables are 0. β_{1-8} are the coefficients of the independent variables. Coefficients provide information with regards to the magnitude and direction of the independent variables' effect on the dependent variable. Coefficients represent the change in the mean of the dependent variable for a one-unit change in the independent variable.

4.2 Variables

The variables used in the regression test along with their respective definitions can be found in the table below.

Variable	Description
YTM	This is the dependent variable, corresponding to each bond's respective yield to maturities.
Maturity	Date on which the principal is due to be repaid.
Issuance Date	Specific date on which the bond is initially sold by the issuer to the investors.
Principal Currency	The primary currency in which the bond is denominated. Qualitative data, converted to categorical dummy variables, is found in <i>Table 3.2.1</i> in the appendix.
ESG Bond Type	Corresponds to the type of sustainable bond issued by the firm. Qualitative data, converted to categorical dummy variables, is found in <i>Table 3.2.2</i> in the appendix.
Amount Issued	Refers to the face value of the bond.
Macaulay Duration	Measure of the weighted average time it takes for the present value of the bond's cashflows to be repaid.
ESG Score	LSEG ESG score, provided through Refinitiv.
Moody's Senior Unsecured Credit Rating	Credit rating assigned by Moody's on the issuer's ability to meet its obligations on senior unsecured debt. Senior debt holders have a higher claim compared to any other debt or equity holders, on the company's liquidation value in the event of bankruptcy. Unsecured debt refers to debt not backed by

	collateral. Qualitative data, converted to categorical dummy variables, is found in <i>Table 3.2.3</i> in the appendix.
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4.3 Data Collection

LSEG’s Refinitiv workspace was used to collect and filter data. This ensures the validity and reliability of the data used. A sample consisting exclusively of companies belonging to the S&P 500 is used in order to mitigate geographical effects on bond pricing, as well as to maintain the same policy framework applied throughout the sample. Since the relationship between ESG rating and GSS+ bond YTM is being investigated, no control database is used. In addition, to avoid data irregularities with regards to maturity and duration, a minimum maturity of 1 January 2024 was set. As such, the filters applied were:

- Issuer: included in the S&P 500
- GSS+ Bond Rating type: all
- Maturity: 01/01/2024 onwards

4.4 Dataset – Omitted Points and Descriptive Statistics

The search yielded 123 GSS+ bonds belonging to 57 companies in the S&P 500. Once the preliminary list was obtained, companies without an ESG rating were removed. Although omitting data points reduces test validity, it is important to maintain the test’s reliability. Given that ESG scores are provided by LSEG through their platform, the scores are not easily calculated. As such, any attempt to replicate LSEG’s scores would result in a deterioration in internal consistency reliability, potentially affecting any relationships found within the sample. Four companies from the sample of 57 did not have reported LSEG ESG scores. This corresponded to 7 bonds.

Credit rating was used as a control variable to improve the regression’s R^2 . Two companies, corresponding to six bonds, did not have reported credit ratings, and were removed

as a result. Although credit rating agencies have more direct comparison scales, for feasibility and reliability reasons they were not applied.

Descriptive statistics with regards to the data sample can be found in *Table 3.4.1* in the appendix.

5. Interpretation of Results

The results from the multi-linear regression model can be found in *Tables 4.1 and 4.2*. Table 4.1 shows the regression statistics. The Pearson correlation coefficient (Multiple R) shows that there is a strong positive linear relationship between the independent and dependent variables. Furthermore, the adjusted coefficient of correlation (Adjusted R²) – a statistical measure representing the proportion of variance in the dependent model explained by the independent variables, adjusted for the number of predictors in the regression model – states that 60% of the dependent variable’s variance is explained by changes in the independent variables. This implies a good model fit, as a substantial proportion of the variation in the dependent variable is accounted for by the model.

Multiple R	0.795094595
R Square	0.632175414
Adjusted R Square	0.602148918
Standard Error	0.592329891
Observations	107

To assess whether multicollinearity occurs amongst the model’s independent variables, a correlation matrix is used (*Table 4.3 in appendix*). The correlation matrix shows that apart from bond maturity and Macauley duration, there are no strongly correlating independent variables. It makes theoretical sense that bond maturity and Macauley duration are correlated, given that duration is simply maturity adjusted for interest rates.

All independent variables are statistically significant at a 5% significance level, aside from Amount Issued (USD). ESG score, the core independent variable being researched, is statistically significant at a 5% level. As a result, the null hypothesis is rejected. The coefficient

implies that for each increase in ESG score, there is a 0.016% increase in yield to maturity. The economic implication of this finding is that firms with high ESG scores have higher GSS+ YTM. This is counter intuitive, as ESG scores reflect a company's environmental performance, with a higher score implying better performance. An important note is that the intercept – that is the value when all independent variables are 0 – is -26.6%. This is very large and can point to an omission of variables or an inappropriate model. However, in this case the intercept has no economic interpretation value, as there is no case in which all dependent variables would be equal to 0.

Table 4.2: Regression Coefficients

	<i>Coefficients</i>	<i>Standard Error</i>	<i>t Stat</i>	<i>P-value</i>
Intercept	-26.578	7.784	-3.414	0.001
Maturity	0.000	0.000	3.569	0.001
Issuance Date	0.000	0.000	2.293	0.024
Principal Currency	-1.067	0.120	-8.870	0.000
ESG Bond Type	0.118	0.053	2.247	0.027
Amount Issued (USD)	0.000	0.000	-0.419	0.676
Mac. Duration	-0.267	0.064	-4.147	0.000
ESG Score	0.016	0.007	2.278	0.025
Credit Rating	0.101	0.030	3.335	0.001

6. Economic Implications of Results

To better understand the factors affecting the model, as well as draw conclusions from this research, the results' economic implications are discussed.

The regression model finds a positive linear relationship between the dependent variable and independent variables. This implies that, on average, as all independent variables increase in absolute value, so does the predicted YTM. To better understand this relationship, each individual independent variable is discussed.

Maturity and issuance date are both significant at the 5% level, however, have coefficients of 0.000. This implies that there is a negligible effect of maturity and issuance date on the predicted value of YTM. Theory describes a positive relationship between bond maturity and yields. As bond maturity increases, the expected yield increases. However, over the past year

yield curves have inverted, with longer maturity bonds exhibiting lower yields than those with shorter maturities. This is typical of recessionary economic environments. Yield curves in the US and EU markets inverted at the end of 2022 in response to inflationary pressures causing central banks to raise interest rates. However, over the past year central banks have increased long-term interest rates, causing yield curves to slowly flatten. Though they are still somewhat inverted, the flattening curve provides dampening effects to the effect of maturity on YTM. As such, the negligible effect of maturity and issuance date on YTM makes theoretical sense.

Principal currency has a coefficient of -1.067, implying for each unit increase in principal currency, there is a corresponding 1.067% decrease in the YTM. As principal currency is a dummy variable, it implies that, on average, bonds denominated in USD have 1.067% higher YTM than those denominated in Euro, followed in equal proportion by GBP and JPY (*Table 3.2.1*). Central bank interest rates are higher in the US than in the UK, EU, or Japan, so at face value this makes theoretical sense. Moreover, a significant risk factor with regards to bonds denominated in foreign currency is currency risk – that is, potential financial gain or loss that can occur because of fluctuations in exchange rates between different currencies. The USD has depreciated in value compared with the JPY (*Figure 3 in the appendix*), EUR (*Figure 4 in the appendix*), and GBP (*Figure 5 in the appendix*) over the past six months, implying investors receive more foreign currency per USD today than six months ago. As such, the expected yield for US bonds increases to counterbalance the increased value of foreign currencies. Nonetheless, given that 85% of the sample consists of bonds denominated in USD, the relationships could be spurious. *Table 6.1* (see appendix) highlights that on average, USD denominated bonds have a higher credit rating than EUR or GBP denominated ones. As such, the relationship between principal currency and YTM is not conclusive, given that a more balanced dataset is not used. A data sample consisting of a more balanced proportion of principal currency must be studied to provide more conclusive evidence.

ESG Bond Type has a statistically significant p-value, with a coefficient of 0.118, stating that for each increase in ESG Bond Type, the YTM increases by 0.118%. This implies that self-labelled green bonds exhibit lower YTMs than third-party certified green bonds. Like principal currency, this relationship is spurious, given that different credit ratings may affect categorical groups. Table 6.2 (see appendix) shows the average ESG and credit ratings by ESG Bond Type. Self-labelled green bonds exhibit on average higher credit ratings than all others with the exemption of sustainability linked bonds. As such, there may be other factors affecting YTMs across different ESG Bond Type groups. To appropriately assess the effect of individual ESG Bond Types on green bond YTMs, a more balanced dataset nullifying all other factors must be used.

Amount Issued is the only independent variable that is statistically insignificant. This goes against Weber and Saravade's (2019) findings, which suggest that bond size affects bond pricing. However, turbulent macroeconomic conditions have brought inflation and interest rates into the spotlight, with investors increasing their focus on the aforementioned factors rather than investment volume. Moreover, market liquidity remains constrained, with GSS+ bonds experiencing oversubscription. As such, individual bond volumes will not be of relevance to eco-conscious investors.

In contrast to Maturity Date, Macauley Duration is found to be significant and exhibits an effect on YTMs. Though they are related concepts, duration reflects the sensitivity of a bond's price to changes in interest rate whilst maturity is simply the date at which the principal is repaid. Flattening yield curves dampen the effect of maturity on bond YTMs, however they are still sensitive to both the timing and size of cash flows. As such, for each additional year of duration, there is a decrease of 0.27% in expected YTM. This reflects the current yield curve inversion.

Credit Score is significant at the 5% level. For each unit increase in credit score an increase of 0.101% in expected YTM is experienced. Since credit score is a dummy variable with the highest credit rating equalling zero, this makes economic sense. As perceived risk increases, so does the expected return.

ESG Score is the independent variable being tested throughout this paper. It is found to be statistically significant at a 5% level, with each unit increase in ESG score reflecting a 0.016% increase in expected YTM. This goes against expectations, as literature shows that investors are willing to pay premiums for climate friendly projects. Like Principal Currency and ESG Bond Type, this relationship is spurious. A lack of homogeneity across all other independent variables makes it difficult to measure a precise effect of ESG rating on YTM. Moreover, the ESG ratings industry is still in its nascency, without significant standardisation and value added to the ESG scores companies receive. It is unclear what the direct implications of ESG scores are. As such, investors cannot make decisions according to them. Contradictions are evident when looking at Oil and Gas companies' ESG ratings, which are at times significantly higher than global standards, despite their entire revenue model relying on eco-unfriendly activities. Nonetheless, one unit of ESG score represents 1% of the overall scoring system. As such, over the entire system, a variability of 1.6% is predicted by the model. The standard error (*Table 4.2*) for ESG score is 0.007, amounting to approx. 44% coefficient. This implies a large degree of uncertainty in the findings, with 44% of the coefficient's value attributed to sampling variability. The remaining 56% is considered the true estimated effect of ESG score on GSS+ bond YTM, amounting to 0.9% variability across the whole scoring scale. As such, this factor is considered to have a negligible effect on YTM bond yields.

7. Conclusion

This paper aimed to show that there was a statistically significant relationship between issuer's ESG scores and the corresponding GSS+ bond yields. This was done using a multi-

linear regression model, the results of which can be found in *Tables 4.1* and *4.2*. Though a statistically significant relationship between ESG scores and GSS+ bond YTM is found, it is negligible, suggesting that investors pay no attention to ESG scores when making investment decisions. Large variation between ESG scores across models, as well as a lack of economic meaning underlying ESG scores, are possible reasons that substantiate the negligible effect.

Moreover, relationships between independent categorical dummy variables Principal Currency and ESG Bond Type are found to be spurious. A more representative dataset, consisting of a balanced proportion of principal currencies and ESG bond types is required to assess their actual effects on GSS+ bond YTM. Furthermore, this dataset only covers companies from the S&P 500, reducing its overall generalisability.

A high coefficient of determination shows a good model fit, with multicollinearity rejected using a correlation matrix. However, further tests must be conducted to probe for overfitting. For example, amount issued was found to be insignificant at a 5% level. A dataset comprising of a more balanced as well as extensive set of data points must be studied to confirm the effects found throughout this paper as well as minimise “noise” in the dataset.

This paper contributes to research by finding potential effects of currency on ESG bond yields, as well as how ESG bond types affect yields. Currency denomination and ESG bond type have significant effects on the characteristics of GSS+ bonds and require further understanding to concretely understand their effects.

Moreover, consumer perception of ESG ratings and their apparent effects and implications must be further studied. In a world where climate safety is of primary concern, finding measurable and consequent methods to understand environmental impact is critical. The inclusion of qualitative data is significant when conducting such a study.

Though ESG scores do not provide insightful information on GSS+ bond pricing, it is clear that ESG bonds effect positive environmental change (Flammer 2021). As such, more research

into this nascent industry is required, to better understand how its positive effects can be leveraged to provide the investor with the maximum attainable information.

8. Appendix

Table 3.2.1: Principal Currency Dummy Variables

Principal Currency	Assigned Value
US Dollar	0
Euro	1
British Pound	2
Japanese Yen	3

Table 3.2.2: ESG Bond Type Dummy Variables

ESG Bond Type	Assigned Value
Self-Labeled Green Bond	0
CBI Aligned Green bond	1
Sustainability Bond	2
Sustainability Linked Bond	3
Social Bond	4

Table 3.2.2: Credit Rating Dummy Variables

Rating	Assigned Value
Aaa	0
Aa1	1
Aa2	2
Aa3	3
A1	4
A2	5
A3	6
Baa1	7
Baa2	8
Baa3	9
Ba1	10
Ba2	11

Table 3.4.1: Dataset Descriptive Statistics

	#	%
Number of Companies	52	100%
All Bonds	107	100%
Average YTM (%)	5.10	
Average Amount Issued (USD)	849 817 943	
Average Maturity	6.42	
Average Duration (Years)	5.27	
Average ESG Score	73.97	

Bonds in US Dollar	91	85.0%
Bonds in Euro	13	12.1%
Bonds in British Pound	2	1.9%
Bonds in Japanese Yen	1	0.9%

Self-Labeled Green Bonds	22	20.6%
CBI Aligned Green bonds	36	33.6%
Sustainability Bonds	30	28.0%
Sustainability Linked Bonds	5	4.7%
Social Bonds	14	13.1%

Aaa Rated Bonds	3	2.8%
Aa1 Rated Bonds	0	0.0%
Aa2 Rated Bonds	1	0.9%
Aa3 Rated Bonds	2	1.9%
A1 Rated Bonds	16	15.0%
A2 Rated Bonds	12	11.2%
A3 Rated Bonds	23	21.5%
Baa1 Rated Bonds	15	14.0%
Baa2 Rated Bonds	23	21.5%
Baa3 Rated Bonds	10	9.3%
Ba1 Rated Bonds	0	0.0%
Ba2 Rated Bonds	2	1.9%

Table 4.3: Independent Variable Correlation Matrix

	Maturity	Issuance Date	Principal Currency	ESG Bond Type	Amount Issued (USD)	Mac. Duration	ESG Score	Credit Rating
Maturity	1.000	0.104	-0.052	-0.313	-0.090	0.965	-0.134	0.118
Issuance Date	0.104	1.000	-0.121	0.018	0.095	0.128	0.223	0.059
Principal Currency	-0.052	-0.121	1.000	-0.140	-0.141	-0.017	-0.063	-0.031
ESG Bond Type	-0.313	0.018	-0.140	1.000	-0.017	-0.360	0.275	-0.107
Amount Issued (USD)	-0.090	0.095	-0.141	-0.017	1.000	-0.103	0.151	-0.296
Mac. Duration	0.965	0.128	-0.017	-0.360	-0.103	1.000	-0.134	0.130
ESG Score	-0.134	0.223	-0.063	0.275	0.151	-0.134	1.000	-0.265
Credit Rating	0.118	0.059	-0.031	-0.107	-0.296	0.130	-0.265	1.000

Legend	1.000	0.99-0.75	0.5-0.25	0.25-0.00
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Figure 4: Yen to USD Spot Rates



Source: Financial Times

Figure 3: Euro to USD Spot Rates



Source: Financial Times

Figure 5: GBP to EUR Spot Rate



Source: Financial Times

Table 6.1: Average ESG and Credit Rating By Principal Currency

	ESG	Credit Rating
USD	74.29	6.32
EUR	71.16	5.92
GBP	81.04	6
JPY	66.79	7

Table 6.2: Average ESG and Credit Rating by ESG Bond Type

	ESG	Credit Rating
Self-Labeled Green Bond	72.32	6.91
CBI Aligned Green bond	71.91	6.19
Sustainability Bond	74.7	5.77
Sustainability Linked Bond	73.46	8.6
Social Bond	80.41	5.71

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