ORIGINAL SCIENTIFIC PAPER
UDK: 336.763.3.067.8
336.1/.5:352(497.11)
005.8:502
DOI: 10.5937/EKOPRE2204206J
Date of Receipt: January 16, 2021

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MUNICIPAL GREEN BOND YIELD BEHAVIOUR

Karakteristike prinosa zelenih obveznica lokalnih samouprava

Abstract

The aim of this paper is to study municipal green bonds as fixed-income instruments used for environmentally friendly projects. This research was motivated by the absence of an effective global CO2 pricing scheme, making green bonds one of the most important instruments to tackle climate change. After an overview of the U.S. municipal green bond market, yields of municipal green bonds vs. ordinary municipal bonds were analysed. S&P U.S. Municipal Green Bond Index and S&P U.S. Municipal Bond Index were used in the study. The methodological framework includes a review of relevant literature, descriptive statistics with correlation analysis and hypotheses testing. As initially expected, significant positive correlation between green bond and ordinary bond yields was found, where green municipal bonds generate slightly lower yields than otherwise similar ordinary bonds. The existence of a statistically significant yield discount, i.e., a green premium, has not been confirmed.

Keywords: *green bonds, climate change, environmentally friendly projects, sustainable finance, municipal bonds, bond yields, green bond labelling.*

Sažetak

Cilj ovog rada jeste proučavanje zelenih obveznica kao instrumenata sa fiksnim prinosom koji se koriste za finansiranje ekološki prihvatljivih projekata. Motivacija za ovo istraživanje rezultat je odsustva efektivnog globalnog mehanizma taksi na emisiju CO2, što zelene obveznice čini jednim od najvažnijih instrumenata za borbu protiv klimatskih promena. Nakon pregleda tržišta zelenih obveznica lokalnih samouprava u SAD, analiziran je prinos zelenih obveznica u odnosu na prinos konvencionalnih obveznica lokalnih samouprava. U istraživanju su korišćeni S&P U.S. indeksi zelenih i konvencionalnih obveznica lokalnih samouprava. Metodološki okvir obuhvata pregled relevantne literature, deskriptivne statistike sa korelacionom analizom i testiranje hipoteza. Kao što je inicijalno očekivano, pronađena je značajna pozitivna korelacija prinosa zelenih i klasičnih municipalnih obveznica, kao i to da zelene municipalne obveznice u proseku generišu nešto niži prinos u odnosu na slične klasične obveznice. Nije potvrđeno postojanje statistički značajnog prinosnog diskonta, odnosno cenovne premije kod zelenih obveznica.

Ključne reči: *zelene obveznice, klimatske promene, ekološki prihvatljivi projekti, održivo finansiranje, obveznice lokalnih samouprava, prinos obveznica, sertifikacija zelenih obveznica.*

Introduction

The cost of green bond financing is the focus of this paper's analysis. The lack of a global carbon pricing scheme makes bond markets one of the most important vehicles to tackle climate change.

As climate changes accelerate, financing of environmentally friendly projects (renewable energy, CO_2 reduction, nature remediation, etc.) is becoming a global priority. Since 1880, the six warmest years have been recorded after 2010 [14]. The consequences of climate change are seen in rapid temperature increases, water acidity, sea level increases, ice glaciers shrinking, and so forth. As additional hazards, droughts and floods are becoming more frequent in recent years [2].

Enormous financial resources are required to decelerate the climate change. According to the most recent energy outlook scenarios, keeping global temperature rise below 2°C, the Paris Agreement's global warming threshold that lowers the probability of disastrous outcomes, will cost USD 12 trillion over the next two and a half decades, by 2050 [20].

Green bonds appeared as a promising financial vehicle to tackle climate change. They are fixed-income instruments created as viable tools for financing environmentally friendly investments, such as sustainable agriculture and forestry, renewable energy, clean transportation, energy efficiency, and biodiversity conservation [20].

In 2007, the first green bond was created by the European Investment Bank (EIB). Since then, various green bonds have emerged, including corporate, sovereign, municipal, and so forth. Supranational institutions followed EIB's lead as the International Finance Corporation issued the first USD 1 billion green bond in 2013 [2].

Globally accepted standardisation of green bonds has yet to be established, as there is no globally recognised system for determining the green status. There are essentially two types of green bond labels. The first one states that the issuer can claim green bond status without third-party confirmation, while the second assumes the third-party certification according to a set of standards. The lack of unified global standards creates a barrier to significant developments of the global green bond market.

The analysis in this paper is focused on the costs of green bond financing. We provide valuable insight into a yield differential between green and ordinary municipal bonds in the U.S. municipal bond market. The findings are in line with one stand of relevant research and literature in this area of study that indicate the absence of a statistically significant green premium for municipal green bonds.

The paper is organised as follows – following the introduction, the second chapter presents the current conditions in the green bond market segment. The third chapter summarises the findings of the relevant literature review. Chapter four consists of the central research hypothesis, methodological framework, and data sources used in the analysis. We present the findings of the empirical analysis and a discussion of the results in chapter five, followed by the paper's conclusion.

The green bond market landscape

In December 2020, the Climate Bonds Green Bond Database captured the representative value of the green bond market to be USD 1 trillion. The green bond market increased by USD 290 billion in 2020, which is an increase of 9% compared to the previous year. The number of issuers increased by 14% to a total of 634. The total number of green bond instruments issued was 1696, with an average size of the instrument being USD 171 million. There were 55 countries involved in the issuance of green bonds, with 34 currencies in which these securities were denominated. The denomination in the three dominant currencies – EUR (48%), USD (28%), and CNY (6%) – increased to 82%. More than 62% of the 2020 green bond volume had a maturity of less than ten years, while almost 40% had a maturity of between 5 and 10 years [20].

Hereunder are the analysed green bond issuances by region, issuer, and investment sector (Figure 1, Figure 2, and Figure 3, respectively).

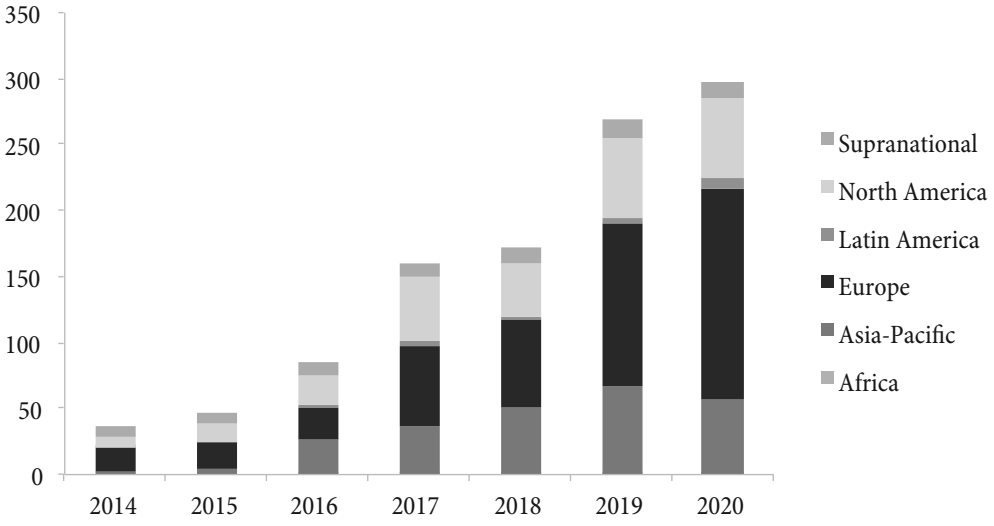
According to data from the Climate Bonds Initiative (Figure 1), issuers of the dominant share of the overall green bonds originated from developed countries (more than 80% in 2020). Emerging markets accounted for 16% in 2020, while the portion of supranational entities was 4%. The most considerable amount of green bonds

was issued in Europe (USD 156 billion, 48%), followed by North America (USD 61.5 billion) and Asia. The USA remained the largest issuer of green debt, reaching USD 52.1 bn (18%) in 2020. Municipal issuers, such as local governments and government-backed issuers, are the most common issuers in the U.S. market [5].

FGreen bond issuers include corporations, governments, municipalities, and supranational organisations. The surge in public sector issuances (France, China and the United States) was typical of the expansion in overall green bond issuances in 2020, while private sector volumes remained stable or diminished. This pattern can be explained by the COVID-19 pandemic crises affecting private sectors more than the public ones. On the other hand, the local government issuers increased by 50%, reaching the level of USD 18.5 bn, where 72 U.S. municipal green bonds worth USD 9.5 billion accounted for more than half of the total number [5].

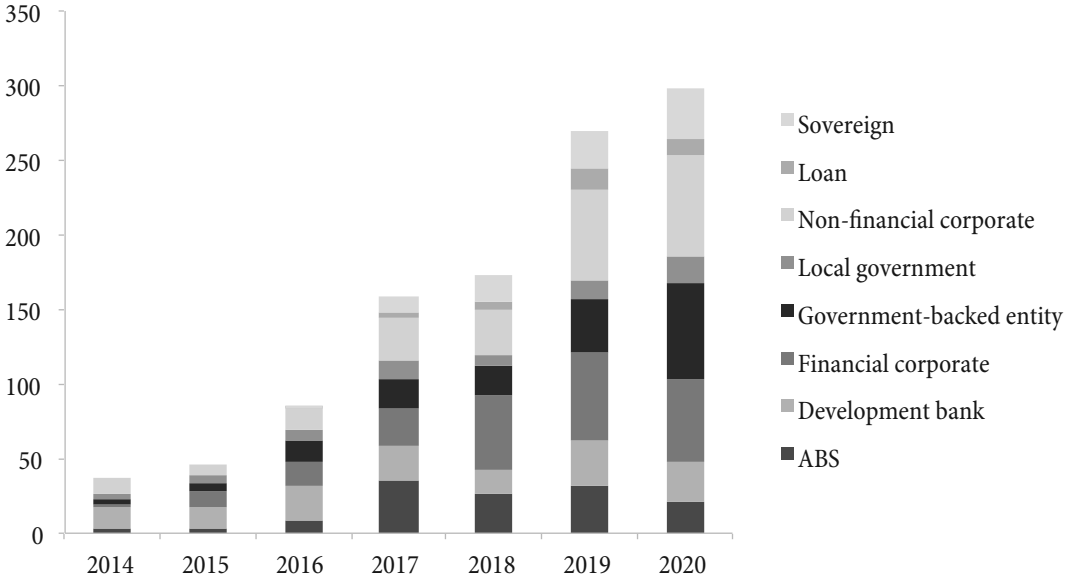
Energy, Buildings, and Transportation were the most common sectors to issue green bonds to finance their activities in 2020, accounting for 85% of the total, followed by Water and Land use.

Figure 1: Green bond issuances by region, in US$ bn, 2014-2020



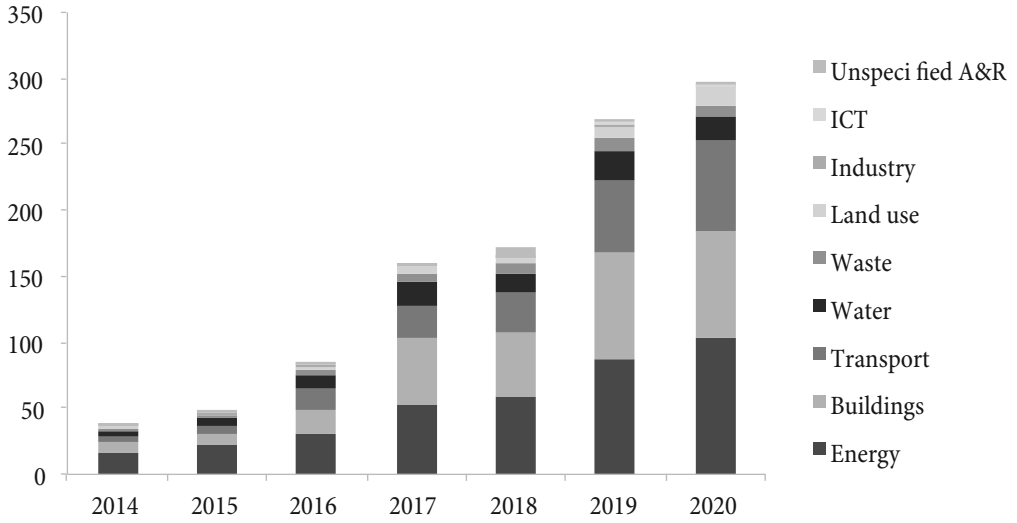
Source: [4].

Figure 2: Green bonds by the issuer, in US$ bn, 2014-2020



Source: [4].

Figure 3: Green bonds by sector, in US$ bn, 2014-2020



Source: [4].

Green bonds reviewed by external reviews made up for 89% of green debt instruments in 2020. Investors actively encourage greater market transparency through information disclosure and are looking for independent confirmation of the legitimacy of green financial instruments [5].

Literature review

Various studies of green bonds emerged in the recent years. The analysis of the relevant literature signals that many papers found the yield on green bonds to be lower than the yield of the similar non-green bonds (known as yield discount or green bond price premium, i.e., greenium). However, the results of different analyses vary depending on, among other factors, the green bond issuer, type of green bond certification, whether the primary or secondary market is surveyed, sample selection, timing, and the methodology used.

Sharfman and Fernando (2008) and Ghoul, Guedhami, Kwok and Mishra (2011) found that an established environmental risk management results in a lower cost of capital and reorientation from equity towards debt financing, accompanied by higher tax benefits. Modestly lower costs of financing for green bonds were identified by Hachenberg and Schiereck (2018), who found limited pricing differential for green and plain vanilla bonds in the secondary market.

Many research papers showed various degrees of green premium – greenium.

Gianfranco and Peri (2019) identified a statistically significant average green premium for the issued green bonds of approximately 18 basis points. Zerbib (2019) found a low green premium of two basis points.

Bachelet, Becchetti and Manfredonia (2019) found that institutional green bonds had a negative yield premium, while corporate bonds had a positive premium compared to non-green bonds unless the corporation certified the green bond. By analysing a sample of 89 bond pairs (green and ordinary bonds), they discovered that green bonds had higher yields and liquidity while being less volatile than their closest non-green bond counterparts. Similarly, Hyun, Park and Tian (2019) found that green bonds that were externally certified had a green premium of around six basis points. Furthermore, the Climate-Bonds Initiative-(CBI)-certified green bonds had a yield discount of roughly 15 basis points.

Baker, Bergstresser, Serafeim and Wurgler (2018) found that green bond after-tax yields at issuance were approximately six basis points below the equivalent ordinary bond yields. The yield discount was increasing after external certification and registration in CBI.

By analysing panel data, Fatica, Panzica and Rancan (2021) discovered a green premium for supranational issuers' green bonds and corporate green bonds. Bour (2019) found evidence of yield discount for green bonds.

The price premium varied depending on the ratings, currency denomination and sector of the issuers.

However, other researchers did not find valid proof of green bond yield discount (green premium).

Partridge and Medda (2020) did not find a strong argument for the existence of green premium in the primary market. Furthermore, Östlund (2015) found no proof of a green premium nor of the fact that green bonds had been traded at a discount compared to their non-green counterparts. Tang and Zhang (2020) found a favourable reaction of stock prices to the issuances of green bonds. Nevertheless, they did not identify a consistently significant green premium, concluding that stock returns behaviour after the green bond announcement is not entirely driven by the lower debt costs.

When comparing municipal green bonds to equivalent ordinary municipal bonds, Larcker and Watts (2020) discovered a very small yield discount, without proof to support a premium on municipal green bonds. Thus, they concluded that the green premium was practically zero. On a wide sample of U.S. municipalities, Karpf and Mandel (2018) investigated U.S. municipal green bonds and found price discounts in the secondary market. In the recent years, however, they stressed out that the quality of municipal green bonds had risen and that premium for some of them became positive.

Different sampling processes, investigated time periods and applied methodologies, securities' credit ratings, issuers' business sector, bond currency denomination, and other characteristics of the issuance and green bonds could all potentially contribute to the stated mixed results found in various studies.

Methodology, data sources and research hypothesis

Research hypothesis

The main research hypothesis in this paper states that:

- Municipal green bonds generate lower average yields compared to ordinary municipal bonds.

There are theoretical reasons to support this assumption.

Firstly, environmentally concerned investors are willing to invest in bonds with lower yields for environmental benefits [18], [15]. In the German market, Kaenzig, Heinzle and Wüstenhagen (2013) showed that consumers are willing to accept a lower yield and pay a price premium of around 16% over the current average for a more environmentally oriented default electricity mix.

According to research by Rommel, Sagebiel and Müller (2016), investors are willing to accept significantly lower yields for financing green renewable energy offered by cooperatives or municipal electricity utilities. Karpf and Mandel (2018) investigated U.S. municipal green bonds and concluded that the credit quality of municipal green bonds was increasing over time, finally resulting in a positive green premium.

Methodology

To obtain objective results of the analysis, the following methods were employed:

- Intensive literature research;
- Descriptive statistic and correlation analysis;
- Hypothesis testing (F-test: for the equality of variances of two samples; T-test: for the equality of means of two samples assuming unequal variances);
- Consultations with experts on climate change and finance.

Data sources

Secondary data sources were employed:

- Data from Climate Bonds Initiative for the 2014-2020 period.
- S&P U.S. Municipal Green Bond Index [23] daily data from 2nd September, 2014 to 31st December, 2020.
- S&P U.S. Municipal Bond Index [22] daily data from 2nd September, 2014 to 31st December, 2020.

Results and discussion

In the analysed period, the S&P U.S. Municipal Green Bond Index and S&P U.S. Municipal Bond Index yields have demonstrated a significant positive co-movement,

where in certain subperiods green bond yields were below (2014, 2015, 2016, 2019, Jan-Feb 2020), while in others they were above the level of their non-green counterpart yields (2017, the first half of 2018, March-Dec 2020).

The behaviour of the green and conventional counterpart bond yields is statistically quite similar, as seen in Table 1 and Figure 4.

Table 1: Summary statistics for S&P U.S. Municipal Green Bond Index and S&P U.S. Municipal Bond Index yields to maturity, 2nd September, 2014–31st December, 2020

	S&P U.S. Municipal Green Bond Index	S&P U.S. Municipal Bond Index
Mean	0.0302395	0.0302476
St. error	0.0000720	0.0000750
Median	0.0306351	0.0308994
St. deviation	0.0028655	0.0029856
Sample variance	0.0000082	0.0000089
Kurtosis	-0.6672738	0.1621299
Skewness	-0.3548610	-0.8120451
Range	0.0164415	0.0178338
Min.	0.0225163	0.0222470
Max.	0.0389579	0.0400808
Sum.	47.8691406	47.8820064
Count.	1583	1583

Source: Authors' calculations.

The municipal green bond index had a mean yield of 3.02395% over the analysed period, compared to 3.02476% for the municipal bond index, with similar levels of dispersion indicators.

As expected, the correlation between the green and ordinary municipal bond yields was high with a positive sample Pearson correlation coefficient of +88.04%.

Next, we tested the relevant hypotheses.

First, the F-test based on two samples was employed to test the null hypothesis of whether the variances of two bond yield populations are equal:

$$H_0: \sigma_{\text{non-green}}^2 = \sigma_{\text{green}}^2$$
$$H_1: \sigma_{\text{non-green}}^2 \neq \sigma_{\text{green}}^2$$

Since F-stat was found to be higher than the F-critical one-tail (5% significance level), 1.0873 > 1.0862, we have rejected the null hypothesis. The variances of the two bond populations were found to be unequal.

Then, we continued with the T-test based on two yield samples assuming unequal variances. The T-test was used to test the null hypothesis that the mean yields of two bond populations are equal.

Figure 4: S&P U.S. Municipal Green Bond Index and S&P U.S. Municipal Bond Index yields to maturity, 2nd September, 2014–31st December, 2020

Source: Authors' presentation based on S&P data [22], [23].

$$H_0: \mu_{non\text{-}green} - \mu_{green} = 0$$
$$H_1: \mu_{non\text{-}green} - \mu_{green} \neq 0$$

If t-stat < -t-critical two-tail or t-stat > t-critical two-tail, we could reject the null hypothesis (5% significance level). This was not the case, since -1.9607 < 0.0673 < 1.9607. Therefore, we did not reject the null hypothesis. The observed difference between the sample means (average $yield_{non\text{-}green}$ - average $yield_{green}$ = 0.000098) was not persuasive enough to state that the average yield of plain vanilla municipal bonds and green municipal bonds differed significantly in the investigated period.

Thus, the research hypothesis was not statistically confirmed, even though the municipal green bonds accounted for a lower average yield in the analysed period compared to the ordinary municipal bonds. The difference, or the yield discount, was found to be very narrow, accounting for less than one basis point (-0.98 bp).

As previously noted, many studies of green bond yield spreads have discovered significant differences in green bond premiums depending on the issuer of the bonds. The most prominent greeniums were found for green bonds of corporations and supranational institutions, while a significant price advantage for green bonds was not found for financial institutions [6]. According to our results, this finding can be extended to municipal green bonds where "greening" seems not to be providing a significant difference in the cost of financing. Our findings are consistent with those of other researchers who found no clear evidence of the existence of a yield discount (green price premium) for green bonds (Larcker & Watts (2020), Partridge & Medda (2020), and others).

Given that the obtained results are potentially reliant on the studied period, the selected samples, and the methodology used, further economic interpretation of the obtained results is needed. The fact that non-financial institutions, such as corporations, usually issue green bonds to finance specific projects offering more transparency to potential investors, while financial institutions and municipalities often use green bonds to fund a pool of projects, which is a process accompanied by less transparency, as a result, may have a higher required rate of return on green bond investments.

Conclusion

Rapid climate change is posing an imminent threat. The need for financial solutions for environmentally friendly projects becomes a necessity. Over time, green bonds emerged as a promising vehicle for addressing the financial needs of green investments.

In this paper, we have analysed green bonds and, in particular, the U.S. municipal green bond market. By comparing yield performances of green vs. non-green municipal bonds, we found no statistically significant advantage in green premium for municipalities issuing green bonds, as the average yield in the investigated period was just slightly lower than plain vanilla municipal bonds' average yield.

The influence of COVID-19 led to global economic and social disruptions. However, the bond market has proven to be a resilient and flexible funding platform, assisting with immediate and longer-term recovery strategies. Over 110 countries are making an effort to become carbon neutral by 2050. Thus, governments must respond to this challenge by implementing large-scale green infrastructure plans as part of the after-COVID-19 recuperation. Green bonds, among others, will be critical to financing these plans.

As green bonds are relatively new fixed-income instruments, future research related to boosting transparency, unifying labelling, and adopting global green standards, among other topics, would be of high investigative and broader public interest.

Acknowledgments

The authors acknowledge support from the Ministry of Education, Science and Technological Development of the Republic of Serbia.

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