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### *Green Bonds – Trends and Development Perspectives*

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Obligacje zielone – trendy i perspektywy rozwoju

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**Słowa kluczowe:** obligacje zielone; eko-inwestycje; rynek globalny; zmiany klimatu; ekologia

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#### **1. The essence of green bonds**

Green bonds are fixed-income instruments, the proceeds of which the issuer uses to finance specific projects that deliver environmental or climate benefits [OECD, 2017, p. 23]. They are particularly well suited to financing sustainable infrastructure investments. As financial instruments, they can offer investors stable long-term returns [Nassiry, 2018, p. 2]. Perhaps this is why “the appetite of institutional investors for green bonds has grown substantially in recent years” [Calder, Kolodzie, 2017, p. 16].

Green bonds are expected to play an important role in responding to the existential threats and enormous costs posed by climate change and other sustaina-

bility challenges that have emerged in recent years [*Global and European Green Finance...*, 2017, p. 3]. Environmental protection has become the main goal of modern sustainable policy development that seeks financing for its projects. Many objectives of the “green” economy have been formulated very ambitiously, which can be seen, *inter alia*, in the Paris Agreement adopted in 2015. It defines a goal to orient countries towards climate-resilient economies and shift to a carbon-neutral global economy before the end of the 21<sup>st</sup> century. At the same time, “making finance flows consistent with a pathway towards low greenhouse gas emissions and climate resilient development” [Article 2(1c) of the Paris Agreement 2015] seems to be a key issue.

The surge in interest in green bonds also reflects a revolution in socially responsible approaches to investment and finance [Chesney et al., 2016; Dziawgo, 2010]. Issuers may be governments (including municipal, state and national governments and export-import banks), intergovernmental organizations (e.g. World Bank or regional development banks), financial institutions, and other corporations. Market actors are increasingly enthusiastic about green bonds [Shishlov et al., 2018, p. 8], and some economists say that investment in green bonds is a fashion and “green is the new black” [Calder, Kolodzie, 2017, p. 1].

Green bonds are usually differentiated on the basis of debt-recourse as defined by the Climate Bonds Initiative (CBI) or on diversity of green bonds available in the market [*Greening India's Financial Market...*, 2016, p. 3]. There are narrow and broad definitions of green bonds [Pawłowski, 2017, pp. 220–221]. The first one includes only “labelled” green bonds (including self-labelled), but the broader definition also applies to unlabelled “pure play” bonds in sectors that are considered green [*Green Bonds: Country Experiences, Barriers and Options*, 2016, p. 5]. Currently, the International Capital Market Association (ICMA) identifies four types of green bonds. In turn, OECD has categorized green bonds into six distinct forms that can be issued as different structures or “types” [OECD, 2015, p. 12]. Additional types may emerge because the market will develop and grow because environmental pressure on the financial sector is wielded more and more by society, employees and shareholders. International initiatives in the financial sector should also be taken into account to promote pro-environmental behaviour [Dziawgo, 2012, p. 134].

As we mentioned, this financial instrument could be tied to mitigating the effects of climate change (e.g. climate bonds) or to a specific environmental issue or technology, such as wind and solar energy efficiency projects, energy retrofits and clean transportation (e.g. renewable energy bonds, energy efficiency bonds and green transportation bonds) [*The Potential of Green Bonds...*, 2017, pp. 15–17]. Such initiatives also include renewable energy, construction of energy efficient buildings, reforestation, sustainable waste management, sustainable land use and biodiversity conservation [Chiang, 2017, p. 7].

Since green bonds are an instrument to shift capital for green investments, the question is whether green bonds really can increase and accelerate green in-

vestments. And what does “green” really mean? The problem is that many market participants have their own definitions of “being green” or “environmentally beneficial”, which may or may not overlap. Different standards for using proceeds have gained acceptance among market actors [Ehlers, Packer, 2017, p. 89]. According to Shishlov et al. [2018, p. 16], a major divergence on green definitions in the market can be found in China. It stems from the national circumstances that improved fossil fuel efficiency can be included in green assets according to the national standard.

Recently, several initiatives have arisen that are working on harmonization of green definitions, e.g. the European Commission’s High-Level Expert Group on Sustainable Finance (HLEG), the China-EU dialogue (the People’s Bank of China and the European Investment Bank) and the ISO standard. These efforts to improve the consistency of definitions, standards and methodologies for determining the eligibility of green projects is important for judging the quality and green character of green bond investments [*Realizing Infrastructure-scale...*, 2016, pp. 7–8].

This article identifies changes on the green bond market. The existing literature devoted to these instruments focuses on their essence, market development and projects that are implemented with their support. Little is known about the structure of the bonds offered, their characteristics or differences from non-green bonds. In the article, the statistical analysis of the green bonds market in time series will be carried out. Relationships between the features of the offered bonds were analysed using the V-Cramer coefficient and the Spearman’s rank correlation coefficient. Type of issuer, issuer’s country of origin, currency of issue and the purpose of financing were especially taken into consideration. This will allow describing the changes taking place in this young and rapidly growing segment of the financial market. Finally, YTM, coupon and payback period of green and non-green bonds were analysed. The differences in their characteristics were described with the support of the significance test of differences. This part of the research widens the analysis and illustrates green bonds’ features in the context of the other bonds.

## **2. Green bonds market – structure and trends of changes**

The green bond market research was based on the Thomson Reuters Eikon database. As of March 31, 2018, 1,202 green bonds with a total nominal value of USD 344.6 billion were registered. This group of bonds in 780 cases was listed on the stock exchange, almost on all significant markets worldwide. A total of 429 instruments had an investment rating, and 43 were classified as high-yield bonds. Other bonds were not assigned a rating. Only 158 bonds were guaranteed. The issuances from 2007–2009 were excluded from the detailed analysis. There were only six of them, with a total value of USD 4.3 billion. They were issued in the middle by the International Bank for Reconstruction and Development and the European Investment Bank.

Table 1. Value and number of global green bond issues in 2010–2017

Specification	2010	2011	2012	2013	2014	2015	2016	2017
Number of issues	53	28	19	43	132	286	219	348
The value of the issue (in billion USD)	2.8	1.3	1.8	10.9	37.6	41.1	89.3	155.5

Source: Authors' own study based on Thomson Reuters Eikon Database.

Analysis of data in Table 1 finds a dynamic increase in the number and value of green bond issues, especially after 2013. In 2013–2015, the number of issues per year doubled. The value of the bonds also grew very strongly, reaching in 2013 over 500%. Such dynamic changes have their source in the diversity of activities of various groups of issuers (Table 2). While transnational organizations, mainly international development banks, have been active at the beginning, since 2013, issues of other entities – government agencies, local government authorities, but first and foremost, enterprises – have been observed. Since 2014, enterprises have been absolutely the most important player on the green bonds market. From 2016, the issuances of government and central banks appeared on the market, but it should be remembered that these entities have been present on the green bonds market longer. Before they issued the bonds themselves, they used the intermediation of international organizations. As a result, they increased their credibility in the investors' view and reduced financing costs. This was particularly important for issuers from developing countries.

Table 2. Number of green bond issues by type of issuer in 2010–2017

Specification	2010	2011	2012	2013	2014	2015	2016	2017
Agency	5	3	0	6	10	23	24	40
Corporate	0	0	0	15	74	200	139	263
Supranational	48	25	19	20	40	60	50	33
Govt/Treasury/Central Bank	0	0	0	0	0	0	1	2
Municipal	0	0	0	2	8	3	5	10

Source: Authors' own study based on Thomson Reuters Eikon Database.

Developing countries, however, are not the most important offerers of green bonds. American entities made the largest number of issues of these instruments. They have been active almost from the beginning of the green bonds market. Issuers from France and Sweden also made many issues. For the past three years, entities from China have joined this group as well. In addition to the listed countries, incidental activity of issuers from other countries is also observed. An example of this is the 49 issues by Malaysian issuers in 2017. The entities from India, which joined the global green bond market at the same time as China, are also very active. We can also see issues from Germany, the Netherlands, Luxemburg and Great Britain. There are more green bond issuer countries, of course, but their share is less noticeable.

Table 3. Number of major green bond issues by issuer's country of origin in 2010–2017

Specification	2010	2011	2012	2013	2014	2015	2016	2017
China	0	0	0	0	1	3	33	43
France	0	0	3	11	34	21	19	37
Sweden	0	0	0	4	22	17	35	45
United States	23	20	11	10	28	179	43	21

Source: Authors' own study based on Thomson Reuters Eikon Database.

Taking into consideration the national criterion and the type of issuer, it can be noted that in the US, corporations and supranational institutions dominate. This is the result of the registration of the World Bank, which is very active in the green bonds market in the US. However, the share of American corporations is growing. A similar situation takes place in France and China. Almost all issuers are corporations. In Sweden, corporations also dominate, although municipal issues are also evident.

The activity of issuers from different countries results in differentiation of currencies in which green bonds are denominated. In the initial period of market development, the use of AUD and JPY is observed. This is linked to the relatively lower cost of money expressed in these currencies because entities from Australia and Japan did not issue green bonds at that time. Since 2011, green bonds in USD have been the most commonly denominated, although the activity of Swedish and French issuers has meant that since 2014, issues denominated in EUR have been noticeable. The share of issue of bonds denominated in AUD and JPY decreases over time, although in the case of JPY, this decrease is not as great. Entry into the market of Chinese entities in recent years results in the growing role of yuan.

Table 4. Number of major green bond issues by currency of issue in 2010–2017

Specification	2010	2011	2012	2013	2014	2015	2016	2017
AUD	13	5	4	3	6	2	5	7
CNY	0	0	0	0	2	1	34	42
EUR	1	2	3	5	25	33	30	61
JPY	8	5	0	4	13	21	19	20
SEK	2	1	3	6	25	18	39	47
USD	3	10	6	12	31	182	65	77

Source: Authors' own study based on Thomson Reuters Eikon Database.

Belonging to a specific country determines the choice of the national currency to a moderate extent. Although it is not strong, such a dependence exists, which is confirmed by the value of the V-Cramer coefficient ( $v = 0.358$ ;  $p = 0.01$ ). Issuers most often select the currency for issuing bonds with a low interest rate. In recent years, however, the level of interest rates in the world has been low, so the advantage of foreign denomination against foreign interest rate risk is insufficient. This results in the increasing use of local currencies. In terms of the type of issuer, there is a strong correlation between the choice of currency and the degree of private ownership. Is-

sues carried out by corporations are strongly related to local currencies, which may indicate aversion to the foreign interest rate risk ( $v = 0.791$ ;  $p = 0.01$ ). In the case of other types of issuers (except for municipal, of which there are too few), there is no such strong dependency. The growing share of corporate green bonds together with the growing number of countries involved in this market will lead to the increasing currency diversification of these instruments.

Table 5. Number of major green bond issues by purpose of financing in 2010–2017

Specification	2010	2011	2012	2013	2014	2015	2016	2017
Eligible Green Bond Projects	53	28	17	40	95	112	98	159
General Purpose	0	0	2	0	2	35	19	15
Green Construction	0	0	0	2	6	5	3	2
Alternative Energy	0	0	0	0	13	92	10	3

Source: Authors' own study based on Thomson Reuters Eikon Database.

Analysing the allocation of funds derived from the issue of green bonds may disappoint. From the very beginning of these instruments, a very general outlined subject of investment has been observed. The group of Eligible Green Bond Projects is the largest, covering half of all issues, although we do see a growing degree of diversification of the purpose of issued bonds over time. Issues for Green Construction or Alternative Energy are noticeable, but Energy Efficiency or Clean Transport also appears more and more often. This demonstrates issuers' increasing competition for investors' attention. The cross-analysis indicates that the diversification of the purpose of the issue occurs primarily in the case of issues by corporations ( $v = 0.691$ ;  $p = 0.04$ ). Public issuers more generally define the purpose of the issue. There was also no statistical relationship between the purpose of the issue and the country of origin of the issuer, which means no specialization of selected national issuers of green bonds. Similarly, in the case of currency of issue, the investment objective is not significantly related to its choice ( $v = 0.217$ ;  $p = 0.05$ ).

The dynamic development of the green bond market is largely due to the social popularity of pro-ecological investments. Analysis of bond features reveals interesting conclusions. Yields of non-corporate bonds are, of course, lower than those issued by enterprises. Supranational institutions issue bonds most often for longer periods, although it must be remembered that their issues are most often implemented in agreement with individual national governments and the features of the bonds depend on their needs. Analysis of the entire market indicates a weak correlation (Spearman's  $\rho = -0.31$ ;  $p = 0.05$ ) between the offered coupon and maturity. At the level of particular groups of issuers, there is usually no statistically significant relationship (for corporate bonds Spearman's  $\rho = -0.28$ ;  $p = 0.05$ ). However, there is a positive relationship between YTM and maturity. For the entire population of green bonds, Spearman's  $\rho = 0.65$ ;  $p = 0.05$ , and for corporate green bonds, Spearman's  $\rho = 0.41$ ;  $p = 0.05$ .

Table 6. Selected features of American green and corporate bonds of the same risk in 2013–2017

Specification	Type of bond	N	Arithmetic average	Median	Standard deviation	p
YTM (%)	Green	141	5.791	6.374	12.916	0.019**
	Non-green	216	5.803	6.449	9.975	
Coupon (%)	Green	141	3.388	3.403	2.034	<0.001**
	Non-green	216	3.287	3.479	2.651	
Payback period (days)	Green	141	2 309	2 201	651	0.061*
	Non-green	216	3 024	2 496	1 324	

The significance of differences was assessed using Mann–Whitney's or *t* test.

\* – statistically significant differences at  $\alpha = 0.05$

\*\* – statistically significant differences at  $\alpha = 0.10$

Source: Authors' own elaboration based on Thompson Reuters Eikon Database.

If we compare green corporate bonds to non-green ones, we will notice a few features that may be the cause of the growing popularity of these instruments. Table 6 compares the basic parameters of US green and non-green bonds with the same ratings. We can see a slightly lower YTM value of green bonds. This applies to both the median value and the arithmetic mean. In both groups, however, there is a high value of the standard deviation, which suggests a wide variation in yields. Green bonds have an average higher coupon value. However, this is not confirmed by the median value. The higher coupon is observed in the non-green bonds group, although in both groups, it is not very diverse. This is apparent from the relatively low standard deviation. Green bonds are issued for significantly shorter times than non-green ones are. This confirms both the average and median value. Both groups of parameters are the least varied, which is indicated by the lowest values of standard deviations. It should be noted, however, that differences in payback periods between green and non-green bonds are the least statistically significant.

## Conclusions

The conducted green bond market analyses indicate an increasing share of corporate issuers and increases in the diversification of the purpose of issuance and the currencies in which the bonds are denominated. This proves the growing competition between issuers. The diversification of the purpose of the issue occurs primarily in issues carried out by corporations. Public issuers define the purpose of the issue more generally. High activity of international financial institutions is related to issues made to developing countries. This allows reducing costs of project financing. Issues carried out by corporations are strongly associated with local currencies, which may indicate aversion to the foreign interest rate risk.

The analysis of the green bonds structure reveals a small relationship between maturity and the offered coupon or YTM. This relationship is not strong, but it indi-

cates that the increase in YTM is accompanied by a decrease in coupon and increase in maturity. This means possible interchangeability between the cost of capital and the time of financing. However, it is difficult to rule on objective differences in risk (which would require construction of a yield curve for both groups of bonds). Green bonds have a number of similarities to typical corporate bonds. They have a similar YTM and coupon. They are, therefore, equally attractive to the investor. They are issued for a shorter time, which allows for more flexible management of the investor's portfolio. Therefore, from the investor's point of view, they seem to be a more attractive instrument than the traditional non-green corporate bond. They carry an additional emotional charge: they support activities that protect the environment. That is why the green label can be the main factor supporting the development of this segment of the financial market and related advanced pro-ecological technologies.

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### **Obligacje zielone – trendy i perspektywy rozwoju**

Celem artykułu jest identyfikacja zmian, jakie zachodzą na rynku obligacji zielonych. Na próbie 1202 obligacji zarejestrowanych w bazie Thomson Reuters Eikon przeprowadzono analizę statystyczną wykorzystującą miary korelacji, test istotności różnic oraz podstawowe statystyki deskryptywne. Przeprowadzone badanie wskazuje na coraz większy udział emitentów korporacyjnych, wzrost zróżnicowania celu emisji oraz walut, w których denominowane są obligacje. Wykazano niewielką zależność pomiędzy czasem zapadalności a oferowanym kuponem czy YTM. W porównaniu do podobnych niezielonych obligacji są one emitowane na krótszy czas, co pozwala na bardziej elastyczne zarządzanie portfelem inwestora.

### **Green Bonds – Trends and Development Perspectives**

The purpose of the article is to identify changes on the green bond market. Using a sample of 1,202 bonds registered in the Thomson Reuters Eikon database, a statistical analysis using correlation measures, a test of significance of differences and basic descriptive statistics was carried out. The study finds an increasing share of corporate issuers and an increase in the diversification of the purpose of issuance and the currencies in which the bonds are denominated. There is a small correlation between maturity and the offered coupon or YTM. Compared to similar non-green bonds, they are issued for a shorter time, allowing for more flexible management of the investor's portfolio.