

## STRUCTURE OF SUSTAINABLE BOND ISSUANCES IN THE VISEGRAD GROUP COUNTRIES IN YEARS 2020-2024

Blandyna PUSZER<sup>1</sup>, Maria CZECH<sup>2</sup>, Dorota ROZMUS<sup>3</sup>, Mateusz MUSZYŃSKI<sup>4\*</sup>

<sup>1</sup>University of Economics in Katowice; blandyna.puszer@ue.katowice.pl, ORCID: 0000-0003-4470-2998

<sup>2</sup>University of Economics in Katowice; maria.czech@ue.katowice.pl, ORCID: 0000-0003-3572-6891

<sup>3</sup>University of Economics in Katowice; dorota.rozmus@ue.katowice.pl, ORCID: 0000-0002-0565-5319

<sup>4</sup>University of Economics in Katowice; mateusz.muszynski@ue.katowice.pl, ORCID: 0000-0001-8722-5541

\* Correspondence author

**Purpose:** The aim of the study is to assess the degree of concentration in the ESG bond market issued in the Visegrád Group (V4) countries in the years 2020-2024, based on the number and value of bond issuances, the type of bonds, and the type of issuer.

**Design/methodology/approach:** The study employed both qualitative and quantitative methods. Initially, a critical analysis of national and international literature on the subject was conducted. Subsequently, in order to assess the degree of market concentration, the Herfindahl-Hirschman Index (HHI) was utilized, calculated based on data obtained from the EFD database.

**Findings:** The analysis of the value of ESG bond issuances in the Visegrád Group countries in the years 2020-2024 indicates a persistent and very high geographic concentration of the market. In each of the years analyzed, the vast majority of issuance value was generated by two or three countries, which is confirmed by the Herfindahl-Hirschman Index (HHI) values ranging from 0,342 to 0,395. According to the adopted interpretative scale, these values are characteristic of an oligopolistic market structure.

**Research limitations/implications:** The short temporal horizon of the analysis, resulting from the gradual development of the ESG debt instruments market in the analyzed countries.

**Practical implications:** The study conducted holds practical value for both market regulators and financial market participants. The research findings can serve as a basis for further analyses concerning the development of the ESG debt securities market.

**Originality/value:** To date, no studies have been conducted to assess the level of concentration in the ESG debt instruments market in the Visegrád Group countries. Therefore, the study should be regarded as innovative.

**Keywords:** green debt securities, sustainable bonds, market concentration.

**Category of the paper:** Research paper.

## 1. Introduction

The intensive development of the sustainable financial instruments market is one of the most significant manifestations of the evolution of international financial markets. Alongside the growing importance of environmental, social, and governance (ESG) objectives, there has been not only an intensification of issuances of specialized debt instruments but also a deepening institutionalization of the principles governing their functioning. Standards such as those developed by the International Capital Market Association (ICMA) (e.g., Green Bond Principles, Social Bond Principles), the Climate Bonds Initiative (CBI) (e.g., Climate Bonds Standard), and the European Green Bond Standard (EUGBS) are creating an increasingly complex regulatory architecture aimed at enhancing market transparency, reducing information asymmetry, and minimizing the risk of greenwashing. At the same time, the latest data indicate that this market is becoming increasingly diverse in terms of issuer structure, financing objectives, and the geographic conditions of capital supply.

Despite the growing interest in the sustainable instruments market, in-depth analyses of the ESG bond market structure and its implications for allocative efficiency, cost of capital, and investment risk profile are still lacking. Previous studies have primarily focused on the integration of environmental, social, and governance objectives (Vulturius et al., 2022), differences between types of instruments (Taghizadeh-Hesary et al., 2021), or the analysis of allocation directions of funds from sustainable bonds (Mishra et al., 2023). Meanwhile, the degree of concentration in the sustainable instruments market is a critical parameter for its assessment, which has so far been insufficiently explored and constitutes a significant research gap.

The aim of this article is to assess the degree of concentration in the ESG bond market issued in the Visegrád Group (V4) countries in the years 2020-2024, across four dimensions: 1) value dimension (the value of ESG bond issuances), 2) quantitative dimension (the number of ESG bond issuances), 3) type dimension (types of green bonds), and 4) sectoral dimension (according to the type of ESG bond issuer). The analysis period covers full calendar years from the moment ESG bond issuances became widespread in the V4 countries. The Herfindahl-Hirschman Index (HHI) was used as a measure of market structure.

The study tests the following hypotheses:

- **H1:** In the years 2020-2024, ESG bond issuances in the V4 countries were characterized by a high level of concentration, both in terms of the nominal value of issuances and the number of issuances carried out.
- **H2:** In the years 2020-2024, the green bond segment had the highest share within the ESG bond sector, indicating that it constitutes the dominant category among all instruments financing sustainable development.

- **H3:** In the years 2020-2024, concentration of ESG bond issuers occurred primarily in the financial sector, and this sector served as the leading issuer in the ESG bond market.
- **H4:** In the years 2020-2024, among the V4 countries, Poland played a leading role in the number of issuances compared to other countries in the region.

The results of the ESG bond market concentration analysis are primarily useful for regulators and supervisory institutions, as they support the design of policies that foster the development of sustainable financing and mitigate systemic risk. At the same time, they serve as a source of knowledge for issuers considering entry into the ESG market. From the perspective of institutional investors, the study's findings provide information on the degree of concentration, which may affect risk assessment, pricing efficiency, and portfolio diversification opportunities. Moreover, this analysis responds to the growing demand within the academic community for in-depth research on the structure of the sustainable instruments market.

The further structure of this article is as follows: the second section presents a review of the existing literature. The third section outlines the research methodology employed. The fourth section discusses the results of the empirical analysis, while the fifth section contains the discussion and concluding remarks.

## **2. Bonds as instruments for financing sustainable development – literature review**

The achievement of sustainable development goals (UN Agenda 2030, 2016) requires the mobilization of appropriate resources to implement sustainable investments. One solution increasingly employed in this area is bonds, whose significance has been steadily growing. Their emergence responded both to the demand from enterprises and organizations for environmentally oriented forms of capital raising and to investors seeking to consciously allocate their capital to projects with ESG relevance. Bonds financing sustainable development can be classified according to various criteria, including the type of issuer, maturity period, interest rate structure, or form of collateral. According to the World Bank, bonds issued for the purpose of financing sustainable investments are debt securities distinguished from other bonds by the objective of issuance (The World Bank, 2015). By definition, the only factor that differentiates ESG bonds from traditional bonds is the issuance purpose, i.e., the scope of use of funds raised from the bond issuance for implementing sustainable investments. According to the European Parliament, environmentally sustainable bonds are among the main instruments for financing investments related to environmentally sustainable technologies, energy efficiency, and resource efficiency, as well as environmentally sustainable transport infrastructure and research infrastructure. Such bonds may be issued by financial and non-

financial enterprises, as well as non-enterprise entities, such as sovereign debt issuers. Sustainable development-linked bonds are exclusively those whose financial or structural characteristics depend on whether the issuer achieves predetermined environmental sustainability targets (European Parliament Regulation, 2023).

In the international financial market, in order for bonds to be recognized as financing sustainable development, they must undergo a certification process overseen by the International Capital Market Association (ICMA), a globally recognized institution issuing widely accepted guidelines in this area. Considering the purpose of issuance, the following types of so-called ESG bonds can be distinguished (Kiertowicz et al., 2025; ICMA, 2025):

- green bonds, the proceeds of which are used to fully or partially finance or refinance new or existing environmentally beneficial projects,
- social bonds, the proceeds of which are used to finance social projects,
- sustainability bonds, the proceeds of which are used to finance both environmental and social projects,
- Sustainability-Linked Bonds (SLB), the proceeds of which serve to finance and support enterprises contributing to sustainable development (from the perspective of environmental, social, or governance objectives),
- Climate Transition Bonds (CTB), the proceeds of which are allocated to support the (re)financing of key projects aimed at achieving the goals of the Paris Agreement, especially in high-emission sectors and/or activities (“high-emission issuers”).

For the purposes of this article, the classification of ESG bonds proposed by ICMA will be applied.

Some authors propose a further subdivision of ESG bonds, distinguishing, among others, blue bonds, forest bonds, and stable bonds. Blue bonds are debt instruments issued by governments, development banks, or other entities to raise capital from environmentally conscious investors for financing marine and ocean projects that generate positive environmental, economic, and climate benefits. Their purpose is to secure funding for projects related to ocean and inland water protection, as well as the development of the so-called blue economy, which includes sustainable fisheries, water waste management, and biodiversity conservation (Bosman, de Mariz, 2023). Forest bonds, in turn, are issued to raise capital for sustainable forest management, environmental protection, and forestry-related projects. They respond to the growing investment needs in the forestry sector, particularly in the context of combating deforestation and the degradation of forest ecosystems (Laskowska, 2020). Stable bonds are a type of ESG bond issued to finance projects that ensure the achievement of environmental and social objectives (Levytska et al., 2024).

Proceeds from ESG bond issuances should be allocated to projects that contribute to the achievement of social, governance, and environmental objectives. The environmental objective relates to climate change, as well as the reduction of energy consumption, pollutant emissions, and waste management. Social aspects include respect for human rights and the promotion of

diversity and equality, regardless of gender or background. The governance criterion primarily concerns issues related to the protection of shareholder rights. The categories used to qualify projects financed through ESG bonds include, among others, the following areas: renewable energy; energy efficiency; pollution prevention; clean transportation (e.g., electric transport and reduction of harmful emissions); eco-efficient products, technologies, and production processes; and green buildings meeting applicable standards and certification requirements (Frydrych, 2023).

One of the criteria for classifying ESG bonds, according to which certified and non-certified bonds can be distinguished, is compliance with certain standards (so-called certification) (Weber et al., 2016, p. 388). The absence of internationally recognized standards in the issuance of green bonds may reduce their credibility among potential investors. Consequently, many issuers choose to utilize certifications developed by reputable and specialized institutions in this field.

Among the most widely used ESG bond standards, whose proceeds are allocated to sustainable investment projects, are those developed by ICMA. These principles are applied by the market and constitute voluntary procedural guidelines that recommend transparency and full disclosure, while promoting integrity in the development of the green bond market by clarifying all details of the issuance process. They provide issuers with guidance on launching bond issuances to finance ESG projects and, by promoting accessibility, accuracy, and integrity of information, help investors assess the environmental impact of their investments. The recommendations contained in these principles particularly pertain to four aspects presented in Table 1.

**Table 1.**  
*Criteria included in the Principles for green, social, and climate transition bonds*

Aspect			
Use of Proceeds	Process for Project Evaluation and Selection	Management of Proceeds	Reporting
<b>Green Bond Principles</b>			
The use of proceeds from green bonds to finance projects that are appropriately described in the documentation and qualify as “green,” providing clear and indisputable environmental benefits. Bond issuance should contribute to the achievement of environmental objectives such as climate change mitigation, climate change adaptation, protection of natural	The issuer should disclose to investors: the environmental sustainability objectives of the eligible Green Projects; the process by which the projects are aligned with the eligible project categories; and additional information on the processes through which the issuer identifies and manages perceived social and environmental risks associated with the given project(s).	The funds raised should be recorded in a separate sub-account to ensure that they are used exclusively to finance green projects. The issuer should inform investors about the planned types of investment of any unallocated net proceeds. The proceeds from the issuance may be managed on an individual basis (bond-by-bond approach) or collectively in the case	The issuer should make available and regularly update reports on the level of utilization of the funds raised, while indicating the projects that have been or are being financed with the proceeds. Information should be provided either in general terms or in aggregated form (e.g., expressed as percentages allocated to specific project categories). The issuer should apply qualitative performance indicators

resources, conservation of biodiversity, and pollution prevention and control.		of multiple green bonds (portfolio approach).	and, where possible, quantitative performance measures, and disclose the key methodology and/or assumptions used in the quantitative assessment of impact.
<b>Social Bond Principles</b>			
The use of bond proceeds for social projects that should deliver clear social benefits. These projects include assets, investments, and activities, as well as other related and supporting expenditures, such as research and development, which may fall into more than one category. Such categories include, among others: water and sanitation infrastructure; access to essential healthcare and educational services; access to housing; job creation; ensuring food security; and socio-economic advancement and empowerment.	The issuer should present to investors: the social objectives; the process used by the issuer to classify projects as social in accordance with the categories listed above; the eligibility criteria and, where possible, any criteria for the potential exclusion of projects; as well as the process for identifying potential risks related to the implementation of social and environmental projects.	Proceeds from the issuance, or an equivalent amount, should be deposited into a sub-account, transferred to a separate portfolio, or otherwise appropriately monitored by the issuer, and reflected in the issuer's formal internal procedures related to its credit and investment policy concerning social projects.	Issuers should collect and disclose information regarding the use of proceeds from the issuance. This information should be updated annually until the proceeds are fully allocated and promptly in the event of material changes. The annual report should include a list of projects to which social bond proceeds have been allocated, along with a brief description of the projects and their expected impact, as well as the amounts allocated.
<b>Climate Transition Bond Guidelines</b>			
The basis is the use of proceeds from bonds for eligible Climate Transition (CT) projects, which should be appropriately described in the legal documentation. CT projects are defined as encompassing assets, investments, and activities, early retirement and decommissioning, as well as other expenditures, such as research and development related to high-emission activities, which lead to a significant and measurable avoidance, reduction, or removal of greenhouse gas emissions. CT projects	Issuers should provide information regarding eligibility criteria, safeguards, classification, and, where applicable, exclusions for CT projects. This should include any links or alignment with official sectoral and market taxonomies, decarbonization pathways and plans, and/or other international and national decarbonization policy frameworks. Issuers should clearly communicate to investors the processes for mitigating significant negative social or environmental impacts. This should cover how "just transition," climate change adaptation, and the protection of nature and biodiversity are taken into account.	Net proceeds from CTBs, or an amount equivalent to such net proceeds, should be recorded in a sub-account, transferred to a sub-portfolio, or otherwise appropriately monitored by the issuer, and also verified by the issuer through a formal internal process related to the issuer's lending and investment activities concerning eligible CT projects and any other eligible projects.	Issuers should provide and maintain easily accessible, up-to-date information on the use of proceeds—annually until full allocation and promptly in the event of material occurrences. The annual report should include a list of projects to which CTB proceeds have been allocated, along with a brief description of the projects, the amounts allocated, and their expected impact.

complement and go beyond the scope of Green Projects under the GBP, aiming to achieve the objectives of the Paris Agreement.			
--	--	--	--

Source: ICMA, 2025b; ICMA, 2025c; ICMA 2025d.

In the case of Sustainability Bonds, the guidelines indicate that these bonds meet the four fundamental criteria of the Principles (Table 1) for green and social bonds, with the former being particularly relevant for eligible green projects and the latter for eligible social projects (ICMA, 2021). The Principles for sustainability-linked bonds are process guidelines that present best practices for financial instruments to incorporate ESG performance forecasts and promote integrity in the development of the market for these bonds by specifying the approach to issuance. The Principles consist of five key elements: the selection of Key Performance Indicators (KPIs); the calibration of sustainability performance targets; bond characteristics; reporting; and verification (ICMA, 2024).

In 2010, the Climate Bonds Initiative (CBI) was established, an international organization working to mobilize global capital and climate action. CBI developed and introduced its system of standards and certification for climate bonds, defining them with reference to green bonds. The system was launched in 2012 to strengthen confidence in the credibility of green bonds and other debt instruments addressing climate change, as well as to facilitate investment decision-making (CBI, 2024, p. 2). The Climate Bond Standard specifies the requirements that issuers must meet to obtain a green certification for a bond, loan, or other debt instrument. The requirements are divided into those to be fulfilled before the issuance of financial instruments and those to be met after issuance. The CBI standards and certification system includes:

- Climate Bond Standard, serving as the overarching system (currently Version 4.2, effective from June 2024).
- Climate Bonds Taxonomy, for the purposes of climate bonds.
- Sector Eligibility Criteria.
- Certification guidelines and documentation (Lipowicz, 2023).

Regardless of international ESG bond initiatives and standards, the European Union has introduced legal regulations in this area. As of 21 December 2024, European Parliament Regulation 2023/2061 came into effect, establishing the European Green Bond Standard (EUGBS). The regulation sets out a detailed set of requirements for bonds issued by financial and non-financial enterprises, as well as sovereign debt issuers, who wish to use the label “European Green Bond” or “EuGB” in relation to such bonds. Issuers are required to link proceeds to investments aligned with the EU Sustainable Finance Taxonomy and to comply with strict reporting and external verification requirements. The objective is to increase transparency and prevent greenwashing. The regulation establishes a voluntary standard, but its adoption is intended to encourage the issuance of high-quality, credible bonds.

EuGBs must be assessed by external verifiers, for whom a registration and supervision system has been established. Issuers are required to complete information templates prior to issuance and to publish allocation reports every 12 months (European Parliament Regulation, 2023). The most significant difference between the EU Green Bond Standard (EUGBS) and other standards is the alignment of the former with European legal regulations, including the so-called Taxonomy, i.e., the regulation defining the framework for sustainable investments.

According to the CBI report, the global sustainable bond market reached a record level of USD 6.5 trillion by the end of the third quarter of 2025, measured according to the adopted methodology, and also demonstrated a strong presence in Europe, providing a significant stimulus to local markets. Various segments of the sustainable bond market are developing at different rates, as indicated by their share of issuance value: green bonds accounted for 61%, social bonds for 19%, sustainability bonds for 19%, and sustainability-linked bonds for 1%. ESG bond issuers are primarily large corporations (27%), financial institutions (26%), development banks (22%), and governments and municipalities (16%). The main currencies of issuance are EUR and USD (CBI, 2025).

According to Lindner and Chung (2023), ESG bonds provide issuers with the opportunity to achieve environmental, social, and governance objectives at lower financing costs while simultaneously diversifying the investor base. Financing environmental and social goals through ESG bonds helps demonstrate the issuer's commitment to these objectives and strengthens ESG-focused expenditures. In emerging markets, both domestic and international ESG bonds have contributed to investor base diversification, although issuing ESG bonds in a small or underdeveloped local bond market in the local currency may lead to market fragmentation and conflict with the objectives of low-cost financing and market development. Lindner and Chung identify the main drivers of ESG bond issuance as follows: emphasizing commitment to environmental and social objectives, the Paris Agreement, and the UN Sustainable Development Goals, while increasing the issuer's international visibility; strengthening ESG capital markets and building a green yield curve; accessing cost-effective financing, particularly for ESG-related projects; and expanding and diversifying the investor base. They note that most ESG bond issuances by developing countries have occurred on international bond markets, due to strong investor demand for ESG bonds. This market is primarily concentrated on USD and EUR denominated issuances, issued under New York or UK law, and serviced by a group of intermediaries - banks, advisors, law firms, and SPO (Second Party Opinion) providers - which have introduced a high degree of standardization to the global ESG bond market, facilitating access for both investors and issuers. However, with regard to domestic ESG bond issuance, countries must balance the opportunities offered by local issuance with the risk of fragmenting the domestic bond market. The authors highlight that many ESG bond issuances are syndicated, with one of the key factors behind this preference being issuers' desire to secure a significant share of ESG-focused investors in their investor base. Syndicate members can engage with ESG investors, helping the

issuer achieve two objectives: diversifying the investor base and promoting its environmental credentials. Syndicated issuances also allow the issuer to direct allocations to specific investors, typically giving priority to ESG-focused investors. Syndicated issuances, supported by a sustainable structuring advisor, help build credible issuance frameworks, select projects, and streamline inter-agency coordination within the issuer's government.

The dynamic development of the ESG bond market in Europe demonstrates the important role regional markets can play in promoting sustainable development. According to a report prepared by the Jagiellonian Institute and the Polish Wind Energy Association, in Poland between 2025 and 2040, as part of sustainable development investments, funds are primarily expected to be allocated to financing the transition to more sustainable energy sources, modernizing transport infrastructure, and adapting buildings and agriculture, with sustainable bonds serving as a key financing instrument (Olszewska, 2024). Research conducted by Frydrych (2023) for the global market on the objectives of ESG bond issuance indicates that the issuance of ESG debt instruments for a selected objective is related to the number of issuances for other objectives. In the period analyzed (2012–2021), 40.11% of bonds were issued by the financial sector (banks and other financial entities), while non-financial entities also had a significant share in ESG bond issuance. Considering ESG bond issuances, the “Clean Transport” objective accounted for 20.65% of all instruments issued. It was also shown that there is a relationship between sectors and ESG bond issuance objectives, although the strength of this relationship is weak. Moreover, a strong positive correlation was observed between ESG bond issuance objectives such as clean transport, energy efficiency, eligible Green Projects, green buildings, and alternative energy. Conversely, a weak inverse correlation was observed between objectives such as climate change adaptation and renewable energy projects, as well as climate change adaptation and alternative energy. De Mariz (2022) notes that the issuance of the four types of bonds classified according to ICMA reached a record level globally in 2021. Sustainability bond issuance now represents nearly 10% of total bonds issued by the public sector and is expected to grow. More than 60% of asset inflows go to asset managers based in the European Union (EU), and the issuances were aligned with ESG principles. Although Europe constitutes the largest market for these bonds within global sustainability bond issuance, other regional markets are catching up. Emerging markets (EM) accounted for 21% of total bond issuance in 2021, and while there remain some barriers to sustainable financing in emerging markets, lessons learned from the development of other markets, particularly Brazil, can be useful for policymakers in developing countries.

Climate and sustainability-linked bonds can provide financing to African governments and corporations for projects that help mitigate climate change, combat biodiversity loss, and support sustainable development. However, less than 0.3% of the global ESG bond issuance volume is allocated to projects in Africa. The African Development Bank, several private banks, and a few publicly listed companies operating in the renewable energy sector issue ESG bonds. In most cases, foreign asset managers are involved, and ESG bonds are often denominated in

foreign currencies to attract international investors. Additionally, a number of sovereign ESG bonds have been issued in Africa, with Egypt and Nigeria showing the highest activity. Certification of ESG bonds, as opposed to self-labeled bonds, is particularly important, as non-certified ESG bonds do not offer similar benefits. Obtaining certification reduces information asymmetry and signals higher bond quality, making certification advantageous for both issuers and investors. This indicates that green macroeconomic policies and financial regulations that reduce information asymmetry should positively impact the development of the African ESG bond market. The study confirms the view that the potential for ESG bond issuance in Africa is enormous and largely untapped (Mutarindwa et al., 2024).

The need for sustainable infrastructure development in India has prompted the search for innovative financing mechanisms, with ESG bonds emerging as a key solution. The potential of ESG bonds to mobilize financial resources for environmentally sustainable projects is evident in several key sectors, including renewable energy, transport, and waste management. Sustainability bonds have a dual impact, generating both environmental and economic benefits. They help reduce carbon dioxide emissions by enabling investments in renewable technologies and efficient infrastructure. Furthermore, these bonds positively influence economic growth by stimulating innovation and creating jobs in green technology sectors (Singh, 2025).

Analysis of the green bond market in Europe indicates that European issuers are dominated by green instruments denominated in EUR, with fixed coupons and maturities of 3-6 years. ESG bonds are most commonly found in sectors where the natural environment is financially significant for business operations, including utilities, real estate, industrials, basic materials, energy, and technology, supporting this hypothesis. The issuance objectives of these bonds by European issuers align with the Climate Bond Standard and the Green Bond Principles. Proceeds from green bond issuances are allocated to objectives such as Eligible Green Projects, Clean Transport, Green/Certified Buildings, Renewable Energy Projects, and Alternative Energy (Frydrych, 2021).

Considering the Visegrad Group (V4) countries, the main issuers of green bonds are the public sector (Poland 66% of total issuance, Hungary 86%) and state-controlled enterprises (Poland – the largest bank and the largest oil company). In the Czech Republic and Slovakia, issuers are primarily private enterprises. The involvement of the public sector is essential for the development of the green bond market, as governments, and particularly the companies dependent on them, should pursue sustainable development and invest in this area. While this is a necessary condition, it is not sufficient. Greater attention should be given to private enterprises (both financial and non-financial institutions) that invest in sustainable development and should be interested in raising capital through green bond issuance (Hadaś-Dyduch et al., 2022).

### 3. Research methodology

To achieve the research objective adopted in this study, the Herfindahl–Hirschman Index (HHI) was applied. This index is one of the most commonly used measures of market concentration in economics and finance. It serves to assess the extent to which a given market, sector, or economic aggregate (e.g., bond issuances, bank assets, or a country's share in the green bond market) is dominated by a limited number of entities. In empirical research, the HHI is widely used in analyses of sectoral, banking, and regional concentration, as well as in studies of financial markets, including the bond market and ESG instruments.

The HHI was independently proposed by Herfindahl in his 1950 doctoral dissertation and by Hirschman, who popularized the index in an article published in the *American Economic Review* (Herfindahl, 1950; Hirschman, 1964). The HHI is defined as the sum of the squares of the market shares of individual entities:

$$HHI = \sum_{i=1}^N s_i^2,$$

where:

$s_i$  – denotes the market share of the  $i$ -th entity,

$N$  – number of entities.

The index values range from 0 to 1 (or alternatively from 0 to 10 000 depending on the scale used). It should be emphasized that the original authors of the index did not propose formal interpretative thresholds. The HHI was initially intended as a comparative tool, used to analyze relative differences in market concentration and its changes over time. One of the first systematic attempts to interpret HHI values was presented by Rhoades (1993), who indicated that values below 0,10 are characteristic of fragmented markets, while an increase in the HHI signals a shift toward oligopolistic market structures.

The most widely used and commonly applied interpretative thresholds were later introduced in competition policy guidelines by the U.S. Department of Justice and the Federal Trade Commission (DOJ/FTC, 2010; 2023). According to this approach, markets with an HHI value below 0,15 are considered low-concentration, those in the range of 0,15-0,25 are considered moderately concentrated, and values above 0,25 indicate high concentration. OECD documents on market concentration and competition policy use the HHI as a standard measure of concentration, referring to similar interpretative ranges applied in regulatory practice (OECD, 2018).

At the same time, academic literature indicates that for markets with elevated concentration, further differentiation of HHI levels is necessary. Scherer and Ross (1990) and Rhoades (1993) emphasize that values exceeding 0,30 are characteristic of oligopolistic structures, while further increases in HHI indicate an increasingly strong dominance of one or several entities. Research in the banking sector additionally suggests that HHI values above

0,40-0,50 can be interpreted as very high concentration, approaching a quasi-monopoly (Bikker, Haaf, 2002).

In the literature, there is no single, universal interpretative scale for the Herfindahl-Hirschman Index. However, specific HHI thresholds are widely applied in industrial economics research, competition policy, and sectoral analyses (Rhoades, 1993; Scherer, Ross, 1990; Bikker, Haaf, 2002; OECD, 2018; DOJ/FTC, 2010; 2023). In this study, a synthetic interpretative scale integrating these approaches was adopted, tailored to the specifics of the ESG bond market in the V4 countries. The adopted scale is intended for organizational purposes and empirical interpretation, rather than for normative market classification. The principles for interpreting HHI values are presented in Table 2.

**Table 2.**  
*Interpretation of HHI values*

HHI	Interpretation
$0.00 \leq \text{HHI} < 0.10$	low concentration (fragmented market)
$0.10 \leq \text{HHI} < 0.20$	moderate concentration
$0.20 \leq \text{HHI} < 0.30$	high concentration
$0.30 \leq \text{HHI} < 0.40$	very high concentration (oligopoly)
$0.40 \leq \text{HHI} < 0.60$	extremely high concentration
$\text{HHI} \geq 0.60$	quasi-monopoly / monopoly

Source: own elaboration based on Rhoades (1993), DOJ/FTC (2010, 2023), Scherer, Ross (1990), Bikker, Haaf (2002).

In this study, the research period covers the years 2020-2024. This is due to the fact that the ESG-related bond market in the Visegrad Group countries only began to develop from 2020 onwards. It should be noted, however, that individual issuances occurred earlier. The first took place in Poland in 2016, consisting of a green bond worth USD 791.86 million, issued by the Republic of Poland. In 2017, no issuances were recorded among the V4 countries. Another single issuance occurred in 2018, again in Poland, amounting to USD 1,234 million, also issued by the Republic of Poland. In 2019, the ESG bond market saw a revival, with four issuances, all green bonds in Poland totaling USD 2,405.63 million, issued by the Republic of Poland. The breakthrough year was 2020, when, in addition to Poland, Hungary also joined the group of issuers. In Slovakia, the first issuance occurred only in 2021.

In this article, the concentration of ESG bond issuances in the V4 countries will be analyzed across the following dimensions: total issuance value, type of bond, and type of issuer. The data used in the study were sourced from the Environmental Finance Data database (efdata.org).

## 4. Research results

### 4.1 Analysis of concentration in the value of ESG-related bond issuances in the V4 countries in 2020-2024

The analysis of the value of ESG-related bond issuances in the Visegrad Group countries over the period 2020-2024 indicates a persistent and very high level of geographical concentration of the market. In each of the analyzed years, the vast majority of issuance value was generated by two or three countries, which is confirmed by the values of the Herfindahl-Hirschman Index (HHI), ranging from 0.342-0.395. According to the adopted interpretative scale, these values are characteristic of an oligopolistic market structure.

At the same time, attention should be paid to the distribution of the number of issuances across individual years. Hungary was the leader in terms of the number of bonds issued in the period 2020-2024; however, this did not always translate into the highest issuance value within the V4 group. As shown by the data presented in Tables 3-6, in 2021, 2023, and 2024 Hungary accounted for the largest number of issuances, while the Czech Republic was the leader in terms of issuance value. This points to significant differences between issuance intensity and the financial scale of individual bond issuances.

**Table 3.**

*Number and value of ESG-related bond issuances in the V4 countries in 2020 (USD million)*

Country	Number of issuances	Value	Share (%)
Czechia	2	1234.38	29.02%
Hungary	6	2237.83	52.61%
Poland	3	781.31	18.37%
Slovakia	0	0.00	0.00%
<b>Total</b>	<b>11</b>	<b>4253.52</b>	<b>100%</b>

Source: own calculation based on efddata.org

The ESG bond market in 2020 (Table 3) in the V4 countries was dominated by Hungary, which carried out six issuances and accounted for more than half of the total issuance value (52.61%). A significant role was also played by the Czech Republic (29.02%), while Poland's share was relatively small (18.37%). Slovakia did not record any issuances. Such a structure, in which two countries generate more than 80% of the total issuance value, is reflected in the Herfindahl-Hirschman Index (HHI) value of 0.395, which, according to the adopted interpretation scale, indicates a very high level of market concentration with a clear dominance of Hungary.

**Table 4.***Number and value of ESG-related bond issuances in the V4 countries in 2021 (USD million)*

Country	Number of issuances	Value	Share (%)
Czechia	6	3554.76	49.05%
Hungary	20	1620.36	22.36%
Poland	4	1554.49	21.45%
Slovakia	3	518.20	7.15%
<b>Total</b>	<b>33</b>	<b>7247.80</b>	<b>100%</b>

Source: own calculation based on efddata.org

In 2021 (Table 4), a more balanced market structure was observed compared to 2020. The Czech Republic remained the largest issuer in terms of value (49.05%); however, the activity of Hungary (22.36%) and Poland (21.45%) was comparable. Slovakia issued ESG bonds for the first time, reaching a 7.15% share of the total issuance value in the V4 countries. The diversification of issuance values among the four countries resulted in a decline in the HHI to 0.342, the lowest level in the entire analyzed period. Despite this a temporary decrease in concentration, according to the adopted interpretation scale, the market in 2021 was still characterized by very high concentration, typical of an oligopolistic structure, although with lower intensity than in the previous year.

**Table 5.***Number and value of ESG-related bond issuances in the V4 countries in 2022 (USD million)*

Country	Number of issuances	Value	Share (%)
Czechia	3	1943.30	25.93%
Hungary	38	4103.84	54.77%
Poland	2	584.79	7.80%
Slovakia	6	861.07	11.49%
<b>Total</b>	<b>49</b>	<b>7493.00</b>	<b>100%</b>

Source: own calculation based on efddata.org

The following year, i.e. 2022 (Table 5), was characterized by a return to a pronounced asymmetry in the distribution of ESG bond issuance values in the V4 countries. Hungary, with 38 issues, accounted for more than half of the total issuance value (54.77%), the Czech Republic for 25.93%, while Poland and Slovakia recorded relatively small shares (7.80% and 11.49%, respectively). The market structure once again assumed an oligopolistic form with a clear leader, which was reflected in an increase in the HHI to 0.387. According to the adopted interpretation scale, this indicates a very high level of concentration, higher than in 2021.

**Table 6.***Number and value of ESG-related bond issuances in the V4 countries in 2023 (USD million)*

Country	Number of issuances	Value	Share (%)
Czechia	2	4425.50	39.36%
Hungary	15	3691.93	32.84%
Poland	9	2676.68	23.81%
Slovakia	2	448.98	3.99%
<b>Total</b>	<b>28</b>	<b>11 243.08</b>	<b>100%</b>

Source: own calculation based on efddata.org

The proportions of issuance values among the three V4 countries became slightly more balanced in 2023 (Table 6). The Czech Republic accounted for 39.36% of the ESG-related bond market value, Hungary for 32.84%, and Poland for 23.81%. Slovakia was the only V4 country to lag clearly behind the others in terms of issuance value, accounting for a share of 3.99%. The market was therefore mainly shaped by the three largest economies of the region, and the level of concentration declined compared to 2022, although according to the adopted interpretation scale it remained very high (HHI = 0.376). At the same time, this was the second most balanced year in the analysed period, after 2021.

**Table 7.**

*Number and value of ESG-related bond issuances in the V4 countries in 2024 (USD million)*

Country	Number of issuances	Value	Share (%)
Czechia	10	4425.50	39.40%
Hungary	14	3691.93	32.80%
Poland	11	2676.68	23.80%
Slovakia	5	448.98	4.00%
<b>Total</b>	<b>40</b>	<b>11 243.08</b>	<b>100%</b>

Source: own calculation based on efdata.org

In 2024 (Table 7), the structure of ESG-related bond issuance values was almost identical to that observed in 2023. The Czech Republic, Hungary, and Poland jointly accounted for 96% of the total issuance value, while Slovakia's share amounted to 4%. The HHI value of 0.321 indicates that the market maintained a very high level of concentration, characteristic of an oligopolistic structure, with a stable distribution of shares among the three main issuers.

In summary, the concentration of ESG-related bond issuance values in the V4 countries in the period 2020-2024 remained persistently very high, as all HHI values fell within the range of 0.30-0.40. Hungary and the Czech Republic played a key role, alternately dominating in individual years. Poland gradually increased its importance, reaching a stable share of approximately 24% from 2021 onwards, whereas Slovakia remained a marginal issuer throughout the entire analysed period.

#### **4.2 Analysis of concentration in the value of ESG-related bond issuances by type of instrument in the V4 countries in 2020-2024**

The analysis of the structure of ESG-related bond issuance in the V4 countries by instrument type (Tables 8-12) shows that the period 2020-2024 was characterized by very high concentration, particularly in the green bonds category, with a relatively small share of sustainability-linked bonds. In most years, the market for a given bond category was dominated by a single country, which is directly reflected in the very high values of the Herfindahl-Hirschman Index.

**Table 8.**

*Value of ESG-related bond issuances by instrument type in the V4 countries in 2020 (USD million)*

Country	Green bond	Sustainability bond	Sustainability-Linked bond	Social bonds
Czechia	1234.38	0.00	0.00	0.00
Hungary	2237.83	0.00	0.00	0.00
Poland	255.37	0.00	525.95	0.00
Slovakia	0.00	0.00	0.00	0.00
<b>Total</b>	<b>3727.58</b>	<b>0.00</b>	<b>525.95</b>	<b>0.00</b>

Source: own calculation based on efdata.org

In 2020 (Table 8), issuances concerned almost exclusively green bonds, and the market was largely divided between two countries: Hungary and the Czech Republic. Poland issued only small amounts of green bonds and SLBs, while Slovakia did not record any issuances. The HHI value of 0.783 indicates an extremely high concentration, typical of a situation in which 1-2 countries account for nearly the entire issuance value. The analysis shows that these countries are the Czech Republic and Hungary, both issuing only green bonds.

**Table 9.**

*Value of ESG-related bond issuances by instrument type in the V4 countries in 2021 (USD million)*

Country	Green bond	Sustainability bond	Sustainability-Linked bond	Social bonds
Czechia	3554.76	0.00	0.00	0.00
Hungary	1620.36	0.00	0.00	0.00
Poland	1298.83	0.00	255.66	0.00
Slovakia	518.20	0.00	0.00	0.00
<b>Total</b>	<b>6992.14</b>	<b>0.00</b>	<b>255.66</b>	<b>0.00</b>

Source: own calculation based on efdata.org

The ESG bond market in the V4 countries in 2021 (Table 9) was characterized by an extremely high concentration (HHI = 0.932), indicating that issuances were practically dominated by a single type of instrument. The vast majority consisted of green bonds, with a total value of USD 6992.14 million, which was more than 27 times higher than the value of the second instrument present, sustainability-linked bonds (USD 255.66 million). The issuance structure shows that the Czech Republic accounted for half of the entire green bond market in the region, while Hungary and Poland had significant but noticeably smaller shares, and Slovakia played a marginal role. SLBs appeared exclusively in Poland and had a marginal significance compared to the dominance of green bonds. It should also be noted that there were no issuances in the sustainability bond or social bond categories.

**Table 10.**

*Value of ESG-related bond issuances by instrument type in the V4 countries in 2022 (USD million)*

Country	Green bond	Sustainability bond	Sustainability-Linked bond	Social bonds
Czechia	1280.47	0.00	662.83	0.00
Hungary	4103.84	0.00	0.00	0.00
Poland	584.79	0.00	0.00	0.00
Slovakia	861.07	0.00	0.00	0.00
<b>Total</b>	<b>6830.17</b>	<b>0.00</b>	<b>662.83</b>	<b>0.00</b>

Source: own calculation based on efddata.org

The structure of ESG-related bond issuances in the V4 countries in 2022 (Table 10) exhibited a quasi-monopolistic pattern (HHI = 0.839), although the level of concentration was slightly lower than in 2021. This indicates that the market remained highly unbalanced and largely dependent on a single dominant segment, namely green bonds, as well as on the activity of selected countries. Hungary was by far the largest issuer of green bonds (4103.84 million USD), accounting for over 60% of the total value of green bond issuances in the region. The Czech Republic held the second position and was the only country issuing sustainability-linked bonds, which only slightly increased the diversity of instruments. Poland and Slovakia held a relatively small share of the market, while no issuances of sustainability bonds or social bonds were recorded.

**Table 11.**

*Value of ESG-related bond issuances by instrument type in the V4 countries in 2023 (USD million)*

Country	Green bond	Sustainability bond	Sustainability-Linked bond	Social bonds
Czechia	1085.66	0.00	0.00	0.00
Hungary	1172.35	0.00	0.00	0.00
Poland	1539.31	430.64	808.37	801.90
Slovakia	637.89	0.00	0.00	0.00
<b>Total</b>	<b>4435.21</b>	<b>430.643</b>	<b>808.37</b>	<b>801.90</b>

Source: own calculation based on efddata.org

In 2023 (Table 11), a significant change occurred in the structure of ESG-related bond issuances in the V4 countries. Poland was the only country issuing all four types of instruments (green bonds, sustainability bonds, sustainability-linked bonds, and social bonds), whereas the Czech Republic, Hungary, and Slovakia issued exclusively green bonds. The increased diversity of instrument types and greater engagement of Poland contributed to a reduction in market concentration. However, the HHI value of 0.489 indicates that the market still exhibited extremely high concentration, although it was noticeably lower than in 2020-2022. Therefore, 2023 can be interpreted as the reduction in concentration levels in the ESG market in the region, both in terms of product variety and geographic distribution, while the market structure remained strongly oligopolistic.

**Table 12.**

*Value of ESG-related bond issuances by instrument type in the V4 countries in 2024 (USD million)*

Country	Green bond	Sustainability bond	Sustainability-Linked bond	Social bonds
Czechia	2286.13	543.48	1595.89	0.00
Hungary	3191.93	500.00	0.00	0.00
Poland	2676.68	0.00	0.00	0.00
Slovakia	448.98	0.00	0.00	0.00
<b>Total</b>	<b>8603.71</b>	<b>1043.48</b>	<b>1595.89</b>	<b>0.00</b>

Source: own calculation based on efddata.org

The following year (Table 12) saw a renewed increase in market concentration by bond type. The HHI value of 0.614 indicates a quasi-monopolistic structure, though less pronounced than in 2020–2022. The Czech Republic, Hungary, and Poland dominated the green bonds segment. The Czech Republic was the only country issuing sustainability-linked bonds, while both the Czech Republic and Hungary issued sustainability bonds. No social bond issuances were recorded in 2024.

In summary, concentration by bond type was higher than the concentration of the overall value of ESG bond issuances in the V4 countries. In 2020–2022, the market exhibited a quasi-monopolistic structure, with HHI values exceeding 0.78 and reaching up to 0.93. The year 2023 brought a noticeable temporary decrease in concentration, primarily due to Poland's activity across all instrument types. In 2024, concentration increased again; however, the market remained more diversified than in 2020–2022. The limited presence of sustainability bonds and the absence of social bonds further reinforced concentration in green bonds and sustainability-linked bonds.

### **4.3 Analysis of concentration in the value of ESG-related bond issuances by type of issuer in the V4 countries in 2020–2024**

Analysis of the structure of ESG bond issuance by issuer type (agency, corporate, financial institutions, municipal, sovereign, supranational) indicates that in 2020–2024 this market in the V4 countries was characterized by very high, and periodically even extremely high, concentration, dominated by single issuer segments in particular years. The Herfindahl-Hirschman Index (HHI) value throughout the analyzed period ranged from 0.341 to 0.501, clearly confirming a persistently concentrated, oligopolistic market structure, with episodes of extremely high concentration.

**Table 13.***Value of ESG bond issuances by issuer type in the V4 countries in 2020 (USD million)*

Country	Agency	Corporate	Financial Institution	Municipal	Sovereign	Supranational
Czechia	0.00	1234.38	0.00	0.00	0.00	0.00
Hungary	0.00	217.94	0.00	0.00	2019.89	0.00
Poland	0.00	781.31	0.00	0.00	0.00	0.00
Slovakia	0.00	0.00	0.00	0.00	0.00	0.00
<b>Total</b>	<b>0.00</b>	<b>2233.63</b>	<b>0.00</b>	<b>0.00</b>	<b>2019.89</b>	<b>0.00</b>

Source: own calculation based on efdata.org

In 2020 (Table 13), the ESG bond issuance market in the V4 countries included only two types of issuers: corporate (52.5% share) and sovereign (47.5% share). Such a strong dominance of these two categories resulted in an HHI value of 0.501, which, according to the adopted interpretative scale, indicates an extremely high level of concentration. The market was, in practice, divided between the corporate segment (Czech Republic, Poland, and Hungary) and sovereign issuances (exclusively Hungary). The absence of activity from financial institutions, municipalities, and supranational issuers further reinforced market concentration.

**Table 14.***Value of ESG bond issuances by issuer type in the V4 countries in 2021 (USD million)*

Country	Agency	Corporate	Financial Institution	Municipal	Sovereign	Supranational
Czechia	0.00	2961.20	593.56	0.00	0.00	0.00
Hungary	0.00	609.99	399.61	0.00	610.76	0.00
Poland	0.00	963.84	590.65	0.00	0.00	0.00
Slovakia	0.00	0.00	518.20	0.00	0.00	0.00
<b>Total</b>	<b>0.00</b>	<b>4535.03</b>	<b>2102.02</b>	<b>0.00</b>	<b>610.76</b>	<b>0.00</b>

Source: own calculation based on efdata.org

In 2021 (Table 14), the market became more diversified due to numerous issuances by financial institutions (2102.02 mln USD) from, among others, the Czech Republic, Poland, and Slovakia. Nevertheless, the corporate segment remained dominant (4535.03 mln USD), and sovereign issuances were limited to a single country (Hungary). This resulted in a decrease in concentration to  $HHI = 0.483$ , which still indicates an extremely high level of concentration. The entry of financial institutions mitigated the dominance of the corporate segment but did not fundamentally alter the asymmetric distribution of bond values by issuer type.

**Table 15.***Value of ESG bond issuances by issuer type in the V4 countries in 2022 (USD million)*

Country	Agency	Corporate	Financial Institution	Municipal	Sovereign	Supranational
Czechia	0.00	1943.30	0.00	0.00	0.00	0.00
Hungary	0.00	592.81	613.50	0.00	2897.54	0.00
Poland	0.00	57.10	527.69	0.00	0.00	0.00
Slovakia	0.00	0.00	861.07	0.00	0.00	0.00
<b>Total</b>	<b>0.00</b>	<b>2593.21</b>	<b>2002.26</b>	<b>0.00</b>	<b>2897.54</b>	<b>0.00</b>

Source: own calculation based on efdata.org

The greatest diversification of issuer types during the analyzed period was observed in 2022 (Table 15). The three active issuer segments (corporate, financial institutions, and sovereign) had relatively similar shares, which led to a partial balancing of the market structure. The HHI value fell to 0.341, the lowest in the years 2020-2024, yet it still indicates a very high level of concentration, typical of an oligopolistic structure, though noticeably lower than in the other years analyzed. Therefore, 2022 can be interpreted as a period of relatively greatest diversification of the ESG market in the V4 countries in terms of issuer type, while maintaining a high concentration.

**Table 16.**

*Value of ESG bond issuances by issuer type in the V4 countries in 2023 (USD million)*

Country	Agency	Corporate	Financial Institution	Municipal	Sovereign	Supranational
Czechia	0.00	0.00	1085.66	0.00	0.00	0.00
Hungary	0.00	750.00	210.80	0.00	211.56	0.00
Poland	0.00	1797.15	1783.07	0.00	0.00	0.00
Slovakia	0.00	0.00	637.89	0.00	0.00	0.00
<b>Total</b>	<b>0.00</b>	<b>2547.15</b>	<b>3717.42</b>	<b>0.00</b>	<b>211.56</b>	<b>0.00</b>

Source: own calculation based on efdata.org

In 2023 (Table 16), the ESG bond market in the V4 countries was characterized by an extremely high concentration (HHI = 0.485), indicating a clear dominance of selected issuer types, although to a lesser extent than in 2020-2022. Data presented in Table 14 show that issuance activity was concentrated in two categories: financial institutions (3717.42 mln USD) and corporate (2547.15 mln USD), which together determined the market structure. Other issuer types were of marginal or zero significance; only sovereign (211.56 mln USD) appeared to a limited extent and exclusively in Hungary. It is worth noting that Poland was the largest issuer in the region, particularly in the corporate (1797.15 mln USD) and financial institutions (1783.07 mln USD) segments. The Czech Republic and Slovakia focused solely on financial institution issuances (1085.66 mln USD and 637.89 mln USD, respectively), whereas Hungary exhibited a relatively more diversified issuer structure, covering corporate, financial institutions, and sovereign segments.

**Table 17.**

*Value of ESG bond issuances by issuer type in the V4 countries in 2024 (USD million)*

Country	Agency	Corporate	Financial Institution	Municipal	Sovereign	Supranational
Czechia	0.00	3882.02	543.48	0.00	0.00	0.00
Hungary	0.00	609.38	1129.14	0.00	1922.46	0.00
Poland	0.00	731.86	1944.81	0.00	0.00	0.00
Slovakia	0.00	32.80	416.18	0.00	0.00	0.00
<b>Total</b>	<b>0.00</b>	<b>5256.07</b>	<b>4033.61</b>	<b>0.00</b>	<b>1922.46</b>	<b>0.00</b>

Source: own calculation based on efdata.org

The values presented in Table 17 indicate that in 2024 the market was again dominated by three main issuer segments, with corporate and financial institutions being the most significant. The HHI index decreased to 0.379 indicating a very high level of concentration, characteristic of an oligopolistic market structure. At the same time, the decline in HHI compared to 2023 demonstrates an improvement in the diversification of issuer types.

In summary, the analysis of concentration by issuer type shows that during 2020-2024, the ESG bond market in the V4 countries remained persistently highly concentrated, with periods of extremely high concentration. All HHI values exceeded 0.34, and in three years they were above 0.48. In 2020-2021, the market was dominated by corporate and sovereign issuances. The year 2022 was characterized by relatively the most balanced market structure in terms of issuer types, as the total values of corporate, financial institutions, and sovereign issuances were similar. In 2023, financial institutions played the dominant role, whereas in 2024 the market was primarily shaped by two issuer segments: corporate and financial institutions.

## 5. Conclusions and Discussion

The results of the present study align with research in the field of sustainable finance and demonstrate that the concentration of ESG bond issuances in the Visegrád Group (V4) countries, considering total issuance value, bond type, and issuer, is heterogeneous.

The application of the Herfindahl-Hirschman Index (HHI) showed that during 2020-2024 there was a persistently very high concentration of both the value and the number of ESG bond issuances in the V4 countries. Considering the value of ESG bond issuances, the market is dominated by the Czech Republic and Hungary. On the other hand, the number of ESG bond issuances in the V4 countries has been increasing, but the market remains fragmented and primarily dominated by Hungary. Consequently, the proposed hypothesis H1, stating that during 2020-2024 ESG bond issuances in the V4 countries were characterized by a high level of concentration both in terms of nominal issuance value and the number of issuances, was not fully confirmed, as the Czech Republic played the key role in 2021, 2023, and 2024, whereas Hungary was dominant in 2020 and 2022. In terms of the number of bonds issued, Hungary dominated throughout all analyzed years. These findings are inconsistent with the observations of Sobik (2023), who indicates that Poland is the regional leader in the development of the green bond market, although the V4's share in the European market remains small compared to Western Europe. Similar conclusions were drawn by Dmuchowski et al. (2023), who argues that Poland remains the leader in the V4 region in terms of both the value and number of green bond issuances. In the other V4 countries, the market develops more slowly, with major barriers including high transaction costs, lack of standardization, and a limited number of ESG-eligible projects. Therefore, hypothesis H4, which posited that during 2020-2024 Poland played

a leading role in the number of issuances compared to other countries in the region, was not confirmed. Hungary was the leading country in terms of issuances count.

The results of the analysis using the Herfindahl-Hirschman Index (HHI) confirm that, during 2020-2024, the structure of ESG bond issuances in the V4 countries by instrument type was characterized by a very high level of concentration. This concentration was primarily due to the dominance of green bonds, with a relatively small share of sustainability-linked bonds. This is due to beneficial impact of green bonds on the issuer's cost of capital structure. Muhammad et al. (2025) indicates that issuing green bonds results in a reduction in the total cost of capital of companies, including the cost of debt and tax-adjusted WACC, and also reduces interest costs, improving the company's tax efficiency (Muhammad et al., 2025). Zhou & Kythreotis (2024) emphasizes that issuers of pure green bonds typically achieve a lower cost of financing compared to issuers of conventional or mixed bonds (Zhou, Kythreotis, 2024). Our results indicated that in the period 2020-2022, this market exhibited a quasi-monopolistic structure. In 2023, concentration was lower compared to adjacent years, as Poland issued all types of bonds, i.e., green bonds, social bonds, sustainability bonds, and sustainability-linked bonds. The conducted research confirms hypothesis H2, according to which, during 2020-2024, the green bond segment had the highest share within the ESG bond sector, indicating that it constitutes the dominant category among all instruments financing sustainable development. These results are consistent with data provided by CBI (2025), where green bonds account for over 60%, and Frydrych (2021), who also highlights the dominance of green bond issuances in Europe. The results of this study, indicating limited market diversification across countries and instrument types, with a clear dominance of green bonds and a marginal significance of other forms of ESG financing, confirm that the concentration around green bonds may limit market access for entities without clearly defined environmental projects (Vulturius et al., 2022; Mishra et al., 2023). Appropriate regulatory guidelines, harmonization and standardization of issuance frameworks, and simplification of reporting requirements and guarantee programs can limit the concentration resulting from the dominance of a single instrument type (Mutarindwa et al., 2024; Vulturius et al., 2022; Mishra et al., 2023).

Considering the structure of ESG bond issuances by type of issuer, it can be observed that the V4 market was characterized by very high (and in some periods, extremely high) concentration, dominated by selected issuer segments in specific years. The main issuers in 2020-2021 were corporate and sovereign entities; in 2022, financial institutions joined them, and in 2024, financial institutions began to play a dominant role. Based on this, hypothesis H3, which assumed that during 2020-2024 the concentration of ESG bond issuers occurred mainly in the financial sector, and that this sector served as the leading issuer in the ESG bond market, was partially confirmed. The dominant role of financial institutions in sustainable bond issuances is also highlighted by Frydrych (2023). Sobik (2023) notes that among all issuers in 2014-2020, the largest number were non-financial corporations, financial institutions,

and public sector entities. This indicates a high utilization of green bonds by the private sector, as well as the popularity of this financial instrument among financial institutions and public sector entities.

The empirical results indicate that the development of the ESG bond market in the V4 countries remains largely dependent on the activity of a limited number of dominant entities. The literature emphasizes that in such conditions, public policy instruments aimed at reducing issuance costs and market entry risks play a significant role in expanding the issuer base (Lindner, Chung, 2023; Hadaś-Dyduch et al., 2022; Azhgaliyeva, Kapsalyamova, 2023). Empirical evidence from studies covering 56 economies between 2010 and 2020 indicates that fiscal policy instruments, such as tax incentives and emission subsidies, significantly increase the likelihood of companies issuing green bonds (Azhgaliyeva, Kapsalyamova, 2023). The experience of individual countries confirms the effectiveness of such solutions. The United States offers tax-preferred green bonds, such as Qualified Energy Conservation Bonds and Clean Renewable Energy Bonds. Chile has introduced tax exemptions for foreign investors purchasing green bonds, while Brazil has introduced income tax-exempt bonds financing wind farm projects (Azhgaliyeva, Kapsalyamova, 2023). These examples demonstrate that selectively designed tax preferences can effectively stimulate both the supply and demand for green debt instruments. Tax breaks and subsidies, income tax deductions, or partial compensation for coupon payments for green bond issuers strengthen the coherence between climate policy goals, financial regulations, and capital market development, fostering increased ESG bond issuance and diversifying the issuer base (Borodin, 2023; Shalini Aggarwal et al., 2025). Therefore, implementing solutions that encourage new issuers seems justified, especially in countries with relatively low issuance activity, such as Slovakia.

The conducted research indicates that during 2020-2024, the ESG bond market in the V4 countries exhibited high concentration, measured by the HHI, both in terms of value and number of issuances, with clear dominance of selected countries. Hungary was the largest issuer in terms of number of issuances, while Slovakia was the weakest. Sectorally, the results confirmed that concentration of ESG bond issuers was highest in the financial and corporate sectors.

These findings make a significant contribution to the literature on sustainable finance and the sustainable bond market, confirming the growing importance of this market segment. ESG bond issuances are increasing dynamically worldwide and in the V4 countries, yet their concentration depends on multiple factors, such as region, issuer type, information quality, and the regulatory environment. In recent years, both the volume of issuances and the emergence of new types of ESG bonds have been observed, although the market remains characterized by considerable geographic and sectoral concentration. From a policy implications perspective, the results indicate that without targeted regulatory, institutional, and tax interventions, ESG bond markets in the Visegrad Group countries may remain highly concentrated. These findings are consistent with observations in the existing literature and

indicate that support for new issuers, diversification of ESG instruments, and further standardization of the regulatory framework could play a key role in building a more resilient and inclusive sustainable finance ecosystem in the region. Future research should therefore consider ESG objectives when analyzing issuances. The ESG bond market in the V4 countries represents an important channel for financing sustainable development, the effectiveness of which depends largely on the type of issuer and the quality of the macroeconomic environment. These results provide a basis for further research on the factors shaping issuers' decisions regarding the issuance of sustainable debt instruments.

## Acknowledgements

Supported by funds from the Ministry of Science under the "Regional Excellence Initiative" Program.



## References

1. Aggarwal, S., Dsouza, S., Joshi, M., Antoun, R., Phan, D. (2025). Environmental, social and governance investing: systematic literature review using ADO model. *Journal of Accounting Literature*. <https://doi.org/10.1108/jal-11-2024-0319>.
2. Azhgaliyeva, D., Kapsalyamova, Z. (2023). Policy support in promoting green bonds in Asia: empirical evidence. *Climate Policy*, Vol. 23, pp. 430-445, <https://doi.org/10.1080/14693062.2023.2167800>
3. Bikker, J.A., Haaf, K. (2002). Competition, concentration and their relationship: An empirical analysis of the banking industry. *Journal of Banking & Finance*, Vol. 26, Iss. 11, pp. 2191-2214, doi: 10.1016/S0378-4266(02)00205-4
4. Borodin, A., Zaitsev, V., Shash, N., Chibisov, K. (2023). Features of Stimulating the Issue of Green Bonds in the Modern Economy. *International Journal of Energy Economics and Policy*. <https://doi.org/10.32479/ijeep.14526>
5. Bosmans, P., de Mariz, F. (2023). The Blue Bond Market: A Catalyst for Ocean and Water Financing. *Journal of Risk and Financial Management*, No. 16, p. 184, doi: 10.3390/jrfm16030184

6. Climate Bonds Initiative (CBI) (2024). *Climate Bonds Standard: Globally recognised, Paris-aligned Certification of debt instruments, entities and assets using robust, science-based methodologies*. Retrieved from: climatebonds.net, 03.12.2025.
7. Climate Bonds Initiative (CBI) (2025). *Sustainable Debt: Global State of the Market Q3 2025*. Retrieved from: climatebonds.net, 04.12.2025.
8. de Mariz, F. (2022). The promise of sustainable finance: Lessons from Brazil. *Georgetown Journal of International Affairs*, Vol. 23, No. 2, pp. 185-190.
9. Dmuchowski, P., Dmuchowski, W., Baczevska-Dąbrowska, A.H., Gworek, B. (2023). Environmental, social, and governance (ESG) model; impacts and sustainable investment – global trends and Poland's perspective. *Journal of Environmental Management*, No. 329, p. 117023, doi: 10.1016/j.jenvman.2022.117023
10. Frydrych, S. (2021). Green bonds as an instrument for financing in Europe. *Ekonomia i Prawo. Economics and Law*, No. 20(2), pp. 239-255, doi: 10.12775/EiP.2021.014
11. Frydrych, S. (2023). Objectives of the ESG bonds issues. *Ekonomia i Prawo. Economics and Law*, No. 22(3), pp. 517-529, doi: 10.12775/EiP.2023.028
12. Hadaś-Dyduch, M., Puszer, B., Czech, M., Cichy, J. (2022). Green bonds as an instrument for financing ecological investments in the V4 countries. *Sustainability*, Vol. 14, p. 12188, doi: 10.3390/su141912188
13. Herfindahl, O.C. (1950). *Concentration in the U.S. Steel Industry*. PhD Dissertation. New York: Columbia University.
14. Hirschman, A.O. (1964). The paternity of an index. *American Economic Review*, Vol. 54, Iss. 5, pp. 761-762.
15. International Capital Market Association (ICMA) (2021). *Sustainability Bond Guidelines*. Retrieved from: icmagroup.org, 03.12.2025.
16. International Capital Market Association (ICMA) (2024). *Sustainability-Linked Bond Principles: Voluntary Process Guidelines*. Retrieved from: icmagroup.org, 03.12.2025.
17. International Capital Market Association (ICMA) (2025a). *The Principles and related guidance*. Retrieved from: icmagroup.org, 01.12.2025.
18. International Capital Market Association (ICMA) (2025b). *Green Bond Principles: Voluntary Process Guidelines for Issuing Green Bonds*. Retrieved from: icmagroup.org, 02.12.2025.
19. International Capital Market Association (ICMA) (2025c). *Social Bond Principles: Voluntary Process Guidelines for Issuing Social Bonds*. Retrieved from: icmagroup.org, 03.12.2025.
20. International Capital Market Association (ICMA) (2025d). *Climate Transition Bond Guidelines*. Retrieved from: icmagroup.org, 03.12.2025.
21. Kiertowicz, S., Węgrzyn, P., Zaremba-Janukowicz, S. (2025). *Finansowanie zrównoważonego rozwoju – podstawowe zagadnienia i aspekty regulacyjne*. Warszawa: Urząd Komisji Nadzoru Finansowego.

22. Laskowska, A. (2020). Zielone obligacje w Polsce – teoria i praktyka. In: L. Kotecki (Ed.), *Zielone finanse w Polsce*. Europejski Kongres Finansowy, Publikacja EKF Online.
23. Levytska, S., Osadcha, O., Tykhonchuk, L., Saltykov, V. (2024). Financial tools for the implementation of environmental projects. *E3S Web of Conferences*, Vol. 558, doi: 10.1051/e3sconf/202455801016
24. Lindner, P., Chung, K. (2023). Sovereign ESG Bond Issuance: A Guidance Note for Sovereign Debt Managers. *IMF Working Paper*, WP/23/58.
25. Lipowicz, M. (2023). Rola i miejsce zielonych obligacji w finansowaniu zrównoważonego rozwoju. *Studies in Risk and Sustainable Development*, No. 397, pp. 1-21, doi: 10.22367/srsd.2023.397.6
26. Mishra, S., Kumar, R., Rout, J. (2023). An overview of green, social, sustainability, and sustainability-linked (GSSS) bonds. *Journal of Social and Economic Development*, Vol. 25, pp. 127-145, doi: 10.1007/s40847-023-00275-8
27. Muhammad, A., Cheng, M., Bangash, R., Osińska, M. (2025). The impact of green bonds on firm cost of capital, and market stability, a global analysis. *Studies in Economics and Finance*. <https://doi.org/10.1108/sef-10-2024-0705>
28. Mutarindwa, S., Schäfer, D., Stephan, A. (2024). Certification against greenwashing in nascent bond markets: Lessons from African ESG bonds. *Eurasian Economic Review*, No. 14, pp. 149-173, doi: 10.1007/s40822-023-00257-5
29. OECD (2018). *Market concentration*. Paris: OECD Publishing.
30. Olszewska, I. (2024). Zazielenienie rynku obligacji. In: L. Kostecki (Ed.), *Zielone finanse w Polsce 2024* (pp. 116-120). Warszawa: UN Global Compact Network Poland; Sopot: Centrum Myśli Strategicznych.
31. Rhoades, S.A. (1993). The Herfindahl-Hirschman Index. *Federal Reserve Bulletin*, Vol. 79, pp. 188-189.
32. Rozporządzenie Parlamentu Europejskiego i Rady (UE) 2023/2631 z dnia 22 listopada 2023 r. w sprawie europejskich zielonych obligacji. *Dz.U. L*, 2023/2631.
33. Scherer, F.M., Ross, D. (1990). *Industrial Market Structure and Economic Performance* (3rd ed.). Boston: Houghton Mifflin.
34. Singh, N., Kumar-Singh, P., Kumar, R. (2025). Green bond sustainable infrastructure development in India. *International Journal of Scientific Research in Engineering and Management*, Vol. 9, Iss. 4, pp. 1-9, doi: 10.55041/IJSREM44388
35. Sobik, B. (2023). Green bonds – financial innovation for sustainability financing: The case of the Polish green bonds market and their development barriers. *Central European Economic Journal*, No. 10(57), pp. 287-303, doi: 10.2478/ceej-2023-0017
36. Taghizadeh-Hesary, F., Yoshino, N., Phoumin, H. (2021). Analyzing the characteristics of green bond markets to facilitate green finance in the post-COVID-19 world. *Sustainability*, Vol. 13, p. 5719, doi: 10.3390/su13105719

37. The World Bank (2015). *What are green bonds?* Washington, D.C.: The World Bank, p. 23.
38. U.S. Department of Justice, Federal Trade Commission (2010). *Horizontal Merger Guidelines*. Washington, D.C.
39. U.S. Department of Justice, Federal Trade Commission (2023). *Merger Guidelines*. Washington, D.C.
40. United Nations (2016). *Agenda 2030: Cele Zrównoważonego Rozwoju*. Retrieved from: [un.org.pl](http://un.org.pl).
41. Vulturius, G., Maltais, A., Forsbacka, K. (2022). Sustainability-linked bonds – their potential to promote issuers’ transition to net-zero emissions and future research directions. *Journal of Sustainable Finance & Investment*, Vol. 14, pp. 116-127, doi: 10.1080/20430795.2022.2040943
42. Weber, B., Staub-Bisang, M., Alfen, H.W. (2016). *Infrastructure as an asset class: Investment strategy, sustainability, project finance and PPP*. Chichester: Wiley.
43. Zhou, D., Kythreotis, A. (2024). Why issue green bonds? Examining their dual impact on environmental protection and economic benefits. *Humanities and Social Sciences Communications*, 11. <https://doi.org/10.1057/s41599-024-04318-1>