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FINANCIAL ANALYSIS OF GREEN BOND ISSUANCE POTENTIAL OF BANKS IN BULGARIA IN THE CONTEXT OF SUSTAINABLE DEVELOPMENT[3]

The objective of this study is to analyse the financial statements of banks operating in Bulgaria to assess their readiness to issue green bonds as a means of attracting financial resources and the various possibilities for subsequent investment of these resources to mitigate climate change and protect the environment. The research was conducted using the tools of statistical analysis and mathematical optimisation models. The findings revealed that the issuance of green bonds is a viable and pragmatic option for accumulating financial resources for both direct and indirect investments in climate change mitigation with moderate risk exposure and optimal expected return. The issuance of green bonds is a novelty for banks in the Republic of Bulgaria. Using economic analysis methods combined with established mathematical models, a comprehensive assessment was made of the readiness of banks to use green bonds as another tool for accumulating financial resources that can be transformed into investments aimed at improving the climate.
Keywords: green bonds; banks; mathematical optimization models; climate change; financial statements
JEL: G21; M41; C61

1. Introduction

The attainment of sustainable development goals and the transition to a low-carbon or green economy require substantial financial resources. Barbu, T. et al. assert that financial support is crucial for fostering activities that mitigate greenhouse gas emissions and assist companies in adapting to climate change effects (Barbu, Boitan, 2019).

The role of the financial sector in supporting sustainable development and addressing climate change has been highlighted by the G-20 and subsequently emphasised by the Financial Stability Board and the Paris Agreement (European Council, 2025), along with its associated nationally determined contributions. Understanding the concept of green financing has

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greatly increased its importance for the banking sector and is prompting banks to increasingly respond to this importance. Their activities include integrating environmental factors into their comprehensive strategic framework and corporate governance, thereby fostering a more sustainable banking model. Shinde, S. notes that for the banking sector, green financing is characterised by financial products and services that take environmental factors into account during the decision-making process for loan approvals, post-loan monitoring, and risk management procedures (Shinde, 2023).

Green financing is growing rapidly in terms of volume and is characterised by a broad range of financial instruments used by issuers and investors. These instruments include green bonds, green loans, sustainable bonds, sustainability-linked bonds, sustainability-linked loans, blue bonds, and social bonds. Fatica, S. et al claim that among the activities and instruments for sustainable financing, green bonds stand out as one of the most promising market solutions for channelling funds towards environmentally beneficial projects and for raising the awareness of environmental risks. (Fatica, Panzica, & Rancan, 2019). Gilchrist, D et al note that green bonds and green loans are frequently regarded by central banks as promising tools for achieving an ecologically friendly economy by greening the financial system itself (Gilchrist, Yu, Zhong, 2021).

Green bonds were introduced as a means to combat climate change and as a channel for various issuers to finance environmentally friendly projects. The European Investment Bank (EIB) was the first institution to issue a green bond in 2007, with the funds raised from this five-year bond allocated to projects in the field of renewable energy and energy efficiency, contributing to the EU's climate change strategy. In 2022, the volume of green bonds in Europe reached 230 billion US dollars, with green bonds comprising 5.4% of the bond market. (Synthesis report on the greening of the financial system Insights for financial actors in advanced and emerging economies, 2024, pp. 4, 20.). The European Central Bank (Opinion of the European Central Bank of 5 November 2021 on a proposal for a regulation on European green bonds (CON/2021/30) 2022/C 27/04CON/2021/30, 2022, pp. p. 4–13,) reported that around 60 % of all green senior unsecured bonds issued globally in 2020 originated in the European Union. The top five issuers of green bonds for the year 2021 are the United States, Germany, China, France, and the United Kingdom. (Bloombergtv, n.d.). The authors of the "Synthesis report on the greening of the financial system: Insights for financial actors in advanced and emerging economies" point out that although green financing instruments are expanding rapidly, there is still some untapped potential for further growth and development.

The objective of this study is to analyse the financial statements of banks operating in Bulgaria to assess their readiness to issue green bonds as a means of attracting financial resources and the various possibilities for subsequent investment of these resources to mitigate climate change and protect the environment.

2. Literature Review

Green bonds are debt instruments designed to raise capital and finance new or existing projects that have a positive impact on the environment and climate change. Green bonds

facilitate the European Union's transition towards a climate-neutral and resource-efficient economy.

The International Capital Market Association (ICMA) created the Green Bond Principles (International Capital Market Association, n.d.) (updated in June 2021, with June 2022 Appendix 1) (GBP), which are a collection of voluntary process guidelines to enhance the transparency and disclosure and promote the integrity of information in the green bonds market by clarifying the approach to issuing such bonds. The Green Bond Principles seek to support issuers in financing environmentally sound and sustainable projects that promote a net-zero emissions economy and protect the environment. The Green Bond Principles (GBP) seek to establish a benchmark for green bonds, ensuring the necessary transparency, accuracy, and comprehensiveness of information that must be disclosed and reported by issuers to investors and other stakeholders through fundamental components and key recommendations. There are four core components of alignment with GBP:

1. Use of Proceeds. The GBP require that the issuer disclose information about the projects that would fall within the permissible categories of green projects. The GBP explicitly recognises several broad categories for eligibility for projects, which contribute to environmental initiatives.
2. Process for Project Evaluation and Selection. The issuers of Green Bonds should clearly communicate to investors the environmental sustainability objectives and the process by which the issuer determines how the projects fit within the eligible Green Projects categories.
3. Management of Proceeds. Issuers should track in an appropriate manner the net proceeds of the Green Bond.
4. Reporting. Issuers should make, and keep, readily available up-to-date information on the use of proceeds to be renewed annually until their full project allocation.

The volume of green bonds in the European Union is rising, which is due to the newly adopted regulations according to the EU taxonomy (Regulation (EU) 2020/852 of the European Parliament and of the Council of 18 June 2020 on the establishment of a framework to facilitate sustainable investment, and amending Regulation (EU) 2019/2088, , 2020), the Regulation on sustainability-related disclosures in the financial services sector (Regulation (EU) 2019/2088 of the European Parliament and of the Council of 27 November 2019 on sustainability-related disclosures in the financial services sector,, 2019, pp. 1–16) the regulations for the accounting of investments. According to Regulation (EU) 2023/2631 (Regulation (EU) 2023/2631 of the European Parliament and of the Council of 22 November 2023 on European Green Bonds and optional disclosures for bonds marketed as environmentally sustainable and for sustainability-related bonds (2023)) adopted in 2023, “European Green Bonds”, as well as the assets backed by such securities, must meet certain requirements regarding issuance, use of proceeds and transparency. The Regulation established a standard for European Green Bonds. It was enforced on 21 December 2024.

The European Green Bonds standard establishes uniform rules for issuers that wish to use the designation ‘European Green Bond’ or ‘EuGB’ for their environmentally sustainable bonds. Issuers are required to invest the entirety of the proceeds of such bonds prior to their

maturity in financing environmentally sustainable activities, both directly (through funding of assets and expenditures related to economic activities that align with the criteria for environmentally sustainable economic endeavours as established in the European Union's taxonomy requirements provided for by Regulation (EU) 2020/852) and indirectly, under certain conditions, through financial assets that finance economic activities meeting these criteria.

The European Green Bonds standard adheres to best practices in transparency and external auditing, thereby fostering the sustainability of investments and protecting investor interests. Issuers of green bonds are required to:

- complete the European Green Bond factsheet and ensure that the completed European Green Bond factsheet has been subject to a pre-issuance review with a positive opinion by an external reviewer (pre-issuance check);
- draw up a European Green Bond allocation report for every 12-month period, accounting for the allocation of the proceeds;
- obtain a post-issuance review by an external reviewer;
- draw up and make public a European Green Bond impact report on the environmental impact of the use of the bond proceeds at least once during the lifetime of those bonds;
- publish a prospectus pursuant to Regulation (EU) 2017/1129 (Regulation (EU) 2017/1129 of the European Parliament and of the Council of 14 June 2017 on the prospectus to be published when securities are offered to the public or admitted to trading on a regulated market, and repealing Directive 2003/71/EC , 2017);
- publish on their websites and make available, free of charge, the factsheet, the prospectus, as well as any other relevant information about the bond until at least 12 months have elapsed after its maturity.

Regulation (EU) 2023/2631 provides for certain information disclosure formats, especially for disclosures made before and after issuance and reporting of EuGB proceeds allocation.

According to Regulation (EU) 2023/2631, European Green Bonds should be reviewed by external reviewers, who shall guarantee that the bonds meet the requirements of the standard and, more specifically, that the financed projects and activities are in accordance with the taxonomy requirements. The external reviewers must be registered and controlled by the European Securities and Markets Authority (ESMA) and shall meet certain strict requirements regarding their professional qualification, transparency, and lack of conflict of interest.

The Regulation (EU) 2023/2631 is a step forward in the process of implementation of the EU's strategy for financing sustainable growth and transition towards a climate-neutral economy with efficient resource utilisation. The new standard will promote consistency and comparability in the green bonds market, which will benefit both the issuers of and the investors in such securities. The European Central Bank (Opinion of the European Central Bank of 5 November 2021 on a proposal for a regulation on European green bonds (CON/2021/30) 2022/C 27/04CON/2021/30, 2022) points out that the existence of

objectively verifiable and transparent requirements for qualification as an EuGB would help to strengthen the credibility of this asset class, reduce reputational risks for issuers and investors as well as informational asymmetries, and limit greenwashing.

The International Finance Corporation identifies several key benefits for emerging market financial institutions to issue green bonds. These include strengthening the bank's resilience, raising awareness of ESG risk, and broadening the investor base. In addition, green bonds can improve investor engagement, increase the bank's visibility, and have a competitive edge in secondary markets, while also fostering positive transformation in the bank's business model (International Finance Corporation Green Bond Handbook: A Step-By-Step Guide To Issuing A Green Bond, 2020).

Research, conducted by Fatica et al. (2019), shows that lead banks, having issued a green bond, reduce their exposure towards more polluting activities. The authors have found proof that the issuers of green bonds tend to support less polluting activities by reducing their lending to sectors with higher emissions intensity. In this manner, both sides of the banks' balance sheets become, to a certain extent, more environmentally friendly. Ultimately, this implies a changed risk profile of banks' balance sheets, particularly through the direct and indirect exposure to environmental and climate-related risks.

The result, obtained by Gangi et al. (2019), implies that bank management focused on environmental issues can reduce the exposure to corporate risks. Yin et al. (2021) found that green financing increases the profitability of non-state-owned banks and reduces their risk.

Policies for disclosing environment-related information affect bank lending. In a research on the Euro Area banks in 2019, Gambacorta et al. (2023) reported a negative relationship between bank environmental disclosure and brown lending.

Although the volume of the green bonds market has rapidly increased since its emergence in 2007, the potential for growth in this market is still vast. Chiaramonte et al. (2024) conclude that central banks, such as the ECB, can promote green financing by prioritising the acceptance of such funding as collateral when providing liquidity to traditional banks. Regulators may further encourage green loans by raising capital requirements for banks that hold excessive loans to polluting companies. Corrective measures imposed by central banks and regulators are essential for promoting green financing. An enhanced transparency regarding the greenness of a bank's credit portfolio could also significantly contribute to the transition.

As of 2022, banks within the EU are obliged to publish a new key indicator – Green Asset Ratio (GAR) (Commission Delegated Regulation (EU) 2021/2178 of 6 July 2021 supplementing Regulation (EU) 2020/852 of the European Parliament and of the Council, 2021). The indicator shows the share of banks' exposures related to taxonomy activities relative to their total assets. Thus, banks are required to provide more accurate and reliable information regarding their exposures related to climate change and the consequent effects on their assets.

Banks in Bulgaria still lack experience in issuing green bonds. To date, only one bank – First Investment Bank (Fibank) – announced its intention to issue green bonds in 2023, aiming to raise BGN 300 million; however, the issuance was postponed due to geopolitical uncertainty

and rising bond yields, as noted in their official statement in late 2023. This is why, in August 2023, the bank adopted and published its Green Financing Framework, prepared in accordance with the Green Bond Principles (GBP) of the International Capital Market Association (ICMA) and the Green Loan Principles (GLP)[4] of the Loan Market Association (LMA) (Loan Market Association. Green Loan Principles, 2018). The bank stated that the Framework adheres to both the United Nations' Sustainable Development Goals and the technical criteria for screening delegated acts on climate as outlined in the Taxonomy Regulation, as well as the components of the European Union's proposal for a European green bonds standard. Fibank's Framework is designed to enable the bank to issue green financing instruments, which may include bonds, mortgage loans, investment loans, project financing, and revolving credit facilities (limited to clean companies). The Framework provides that the bank shall publish an annual Report on Allocation and Impact on a portfolio basis on its website, providing information about the environmental impacts of the portfolio comprising Eligible Green Projects and outlining progress in the allocation of net proceeds from current green financing instruments. However, a little over a month after announcing its intention to issue green bonds, Fibank stated that it had decided to temporarily postpone the issuance due to the sharply deteriorating geopolitical environment and record increases in yields on international debt issues following recommendations from the lead managers of the issuance – Citigroup Global Markets Limited, Landesbank Baden-Württemberg and Raiffeisen Bank International AG.

An amendment to the Public Offering of Securities Act is being prepared in Bulgaria in connection with the entry into force of the European Green Bond Regulation (Regulation (EU) 2023/2631). The Financial Supervision Commission and the Bulgarian National Bank are the competent authorities responsible for the implementation of the regulation. The amendments to the Public Offering of Securities Act implement the necessary regulatory provisions regarding the issuance of green bonds by banks operating in Bulgaria and prevent the disclosure of greenwashing information, benefiting the issuers of such bonds.

3. Research Methodology

In terms of their essential characteristics and issuance mechanism, green bonds do not fundamentally differ from conventional bonds that banks, as joint-stock companies, are permitted to issue in accordance with the stipulations of Article 204, paragraph 1, item 1 of the Commerce Act in order to accumulate the financial resources they need to carry out their active banking operations. The only difference, as mentioned in the earlier sections of this paper, is that the proceeds of green bonds must be used to actively fund various environmental activities.

The key objectives of this study can be formulated as follows:

[4] GLP were developed with the support of ICMA and follow or adhere to many of the principles included in GBP. Green projects comprise the same list of green project examples published by ICMA in GBP. GLP also refers to the four core components of GBP's framework, viz. Use of Proceeds, Process for Project Evaluation and Selection, Management of Proceeds, and Reporting.

- To assess the feasibility of bonds issued by banks operating in Bulgaria as a means for raising financial resources;
- To evaluate the potential opportunities of banks in Bulgaria to allocate the proceeds from green bond issuance into qualifying environmental projects;
- To assess the choice for investing the proceeds of green bonds with a view to realising the maximum expected return on investment.

3.1. Objective One: Assessment of the feasibility of bonds issued by banks operating in Bulgaria as a means for raising financial resources

Green bonds are essentially debt financial instruments that are entirely analogous to conventional and covered (mortgage) bonds, which serve as a well-established mechanism employed by banks to attract external resources. What is specific about them is that the proceeds of green bonds are allocated in full or partially to financing projects focused on environmental sustainability. Moreover, there are certain organisational specifics regarding the overall issuance process (including reviews of the disclosure of information regarding the green bonds by external reviewers, preparation of environmental impact reports, etc.), which were discussed in the preceding sections of this publication. The alternative mechanism for granting, assessment, and repayment of loans using green bonds, compared to those using conventional and covered bonds, allows for a reliable evaluation of the applicability of bond issuance practices of Bulgaria's banking institutions. Consequently, it becomes possible to assess reliably the potential for integrating green bonds as a financial resource mobilisation mechanism aimed at supporting efforts to mitigate the negative effects of climate change and protect the environment.

The primary source of information for this research (especially regarding the first research objective) is the financial statements, disclosed by banks to the general public. To provide an accurate and objective assessment of the bond issuance practices of banks, data from the past two years (covering the period of 2022-2023) was used. The aim of investigating such practices is to determine the propensity of the banks operating in Bulgaria to issue bonds as a debt instrument for accumulating financial resources. To this end, a comparative and structural analysis was conducted at the level of the banking system in Bulgaria, revealing key results and trends.

3.2. Objective Two: Analysis of banks' opportunities and utility to issue green bonds

A thorough investigation was conducted into the capacity of banks to issue green bonds and allocate the proceeds toward environmentally sustainable projects in compliance with applicable green finance principles. The primary source of information for this part of the study is the general-purpose financial reports published by banks. To achieve this objective, the authors have examined all banking products related to financing the aforementioned environmentally friendly activities.

3.3. Objective Three: Assessment of the choice for investing the proceeds of green bonds with a view to realising the maximum expected return on investment

Like all other investments, the green investments of banks in Bulgaria aim to achieve maximum optimality between risk and the expected return. One of the measures taken by these banks to encourage such investments is to maintain competitive (lower) interest rates compared to credits extended for other purposes by the bank. To find an optimal balance of risk and expected return, banks must set specific objectives with restrictive conditions which would ensure that the green bond proceeds shall be invested in certain activities. These restrictive conditions allow for a choice from certain options that meet the set objective. Given the strict goal-oriented nature of the investment, by issuing green bonds (with proceeds invested only in environmentally-oriented projects), the bank must diversify the options for investing the accumulated resources among available alternatives.

Linear mathematical optimisation is regarded as an effective tool for assessing the viability of investments. This method allows for the identification of the feasible region of alternative solutions while accommodating specific constraints. A defining characteristic of linear optimisation models is the presence of an objective (target) function, which denotes the desired economic outcome. For the purposes of this study, the target function represents the volume of investments in green debt instruments that can provide the highest yield given the resource constraints within the capital accumulated through the issuance of green bonds. Mathematically, the target function in this model can be expressed as:

$$Z(X) = \sum_{j=1}^{n} c_j x_j \rightarrow max$$

The equation can be simplified as:

$$Z(X) = c_1 x_1 + c_2 x_2 + \ldots c_n x_n \rightarrow max,$$

where:

c is the return (yield) of the debt instruments of a given issuer;

x – the volume of financial instruments (number of securities), which the investing bank should buy to achieve a maximum return on the investment.

To achieve the set target function of maximising profit, we have to consider its constraints. In the mathematical model, these will be represented as a system of equations/inequalities. In the context of subsequently investing the green bond proceeds, the primary constraint will be the diversification of investments, specifically, the condition that the bank should set the largest permissible volume of the total resource to be allocated to any single financial instrument issued by a given issuer. As this limitation (the maximum allowable amount of resources designated for a particular investment) must not be exceeded, it will be represented by an inequality with the symbol "≤". The number of inequalities in the model's system will vary depending on the number of types of financial instruments or issuers in which the investor bank intends to invest. Given that green bonds are still not very popular among the banks in Bulgaria, a hypothetical scenario is proposed, wherein a specific amount of accumulated financial resources is to be invested in financial instruments from two issuers.

In this case, the system will be structured as follows (Gocheva-Ilieva & Kulina, 2019, pp. 125-165):

$$a_{11}x_1 + a_{12}x_2 + \ldots a_{1n}x_n \geq b_1$$

$$a_{21}x_1 + a_{22}x_2 + \ldots a_{2n}x_n \geq b_2$$

$$a_{31}x_1 + a_{32}x_2 + \ldots a_{3n}x_n \leq b_3$$

……

$$a_{n1}x_1 + a_{n2}x_2 + \ldots a_{nn}x_n \leq b_n$$

$$x_1 \geq 0, x_2 \geq 0 \ldots x_n \geq 0,$$

where:

a is the unit price of the financial instrument of a given issuer;

x – the volume of financial instruments (number of securities), which the investing bank should buy, given the resource constraint.

Therefore, by solving the system of linear inequalities, the region of feasible solutions will be graphically outlined. Through the scenario established for this part of the study, we shall graphically identify the area of points that illustrate the possibilities for acquiring a specified quantity of financial instruments while adhering to the resource constraints previously established by the investing bank. This outlines the area of permissible solutions that satisfy the investing bank. If we denote this area as G, then each point representing a particular volume of acquired financial instruments (x) will be an element of this region, or $x_1, x_2, \ldots x_n, \in G$.

Since these variables are physical units (number of securities), the non-negativity constraint (≥) shall be applied for the volume of financial instrument „x“.

4. Results

The results of the study are presented in the order of the set research objectives.

4.1. Results related to the first objective: Assessment of the feasibility of bonds issued by banks operating in Bulgaria as a means for raising financial resources

The volume of bonds issued by banks in Bulgaria in 2023 and 2022 is shown in Table 1.

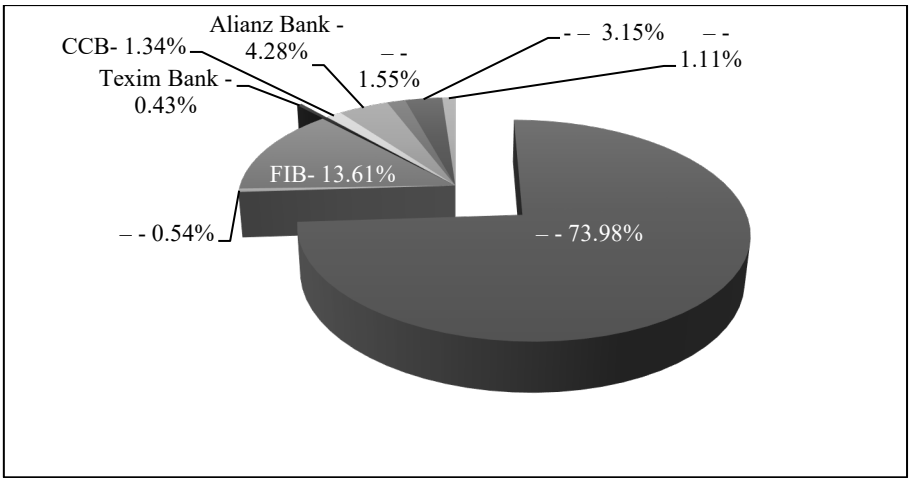
According to the information in the table above, of all 17 banks operating on the territory of the country, 52.94% had bond issues in 2023, while in 2022, the share of banks with bond issues was 41.18%. Structurally, in 2023, the largest relative share was reported for Unicredit Bulbank and the smallest (0.43%) for Teximbank (Figure 1).

Table 1. Bonds issued by banks in Bulgaria in 2023 and 2022

Bank	2023 BGN thousand	2022 BGN thousand
Unicredit Bulbank	1 401 400	313 701
UBB	0	0
DSK	0	0
Eurobank	0	0
Investbank	10 221	0
FIB	257 871	256 861
Texim Bank	8 074	22 160
CCB	25 463	25 450
Alianz Bank	81 096	0
BACB	29 370	29 370
TBI	59 654	19 843
Procredit	0	0
International Asset Bank	0	0
D Commerce Bank	0	0
Bulgarian Development Bank	0	0
Tokuda Bank	0	0
Municipal Bank	21 081	21 081
Total:	1 894 230	688 466

The data in Table 1 was sourced from publicly disclosed financial statements available on each bank's official website and cross-referenced with the Bulgarian National Bank's statistical releases for verification.
Source: bank financial statements

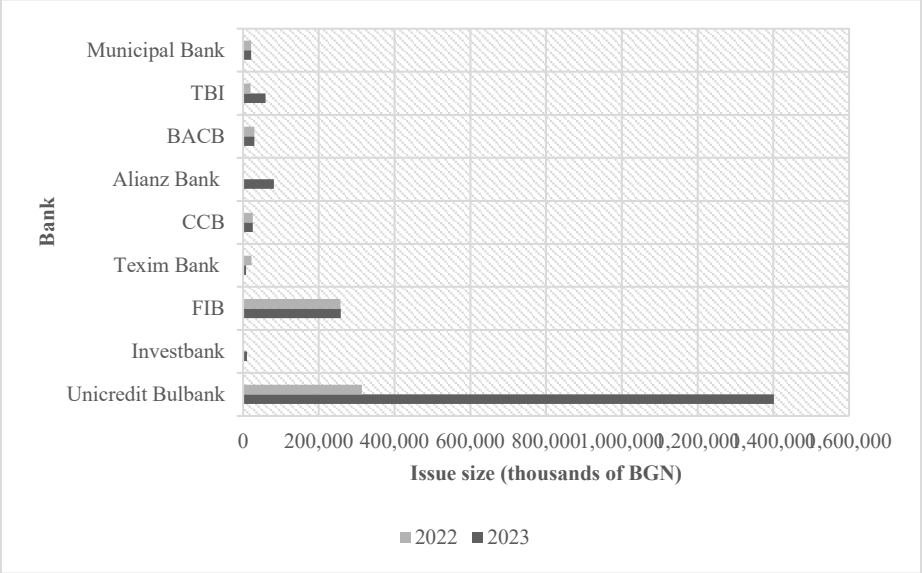
Figure 1. Relative share of banks in bond issuance in 2023



Source: author's own elaboration.

In addition to an increase in the number (relative share) of banks with bond issuances, an overall increase (with certain exceptions) is also observed in the overall absolute volume of bond issues in 2023 compared to 2022 (Figure 2).

Figure 2. Comparative analysis of bond issues of banks in Bulgaria for the period 2022-2023



Source: author's own elaboration.

Overall, the green bond issues in the banking sector increased with over one billion BGN (BGN 1 205 764 thousand) over the period.

The data presented above leads to the conclusion that the issuance of bonds is a viable mechanism for accumulating the financial resources the banks need for the investment projects. Given the similar specifics of conventional and covered bonds compared to green bonds, it can be inferred that, in terms of the organisation of the issuance process, banks in Bulgaria can relatively swiftly and adaptively issue green bonds in compliance with the current legislation.

4.2. Results related to the second objective: Analysis of banks' opportunities and utility to issue green bonds

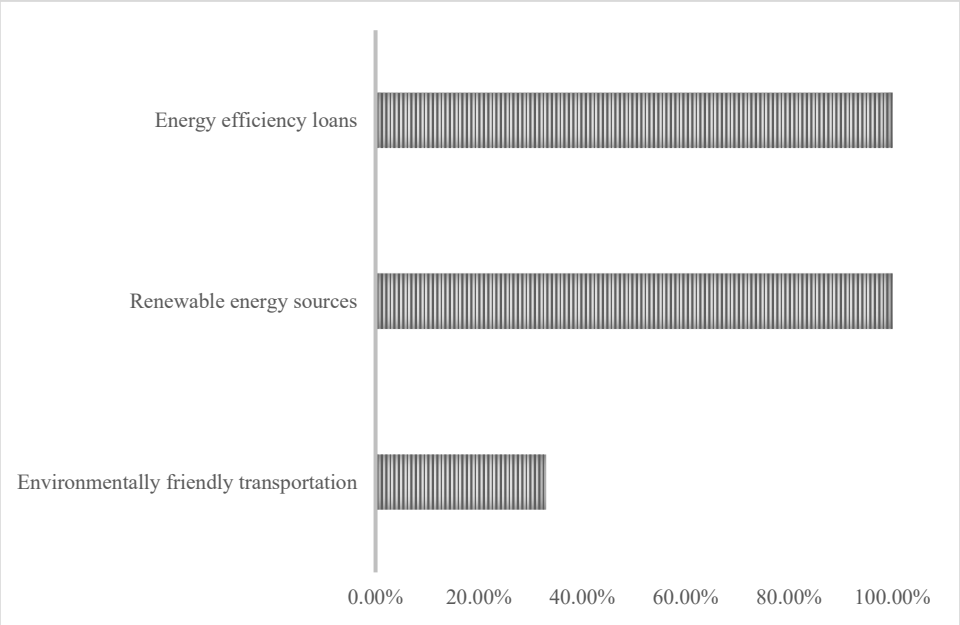
Due to the strict requirements for targeted investment of the proceeds of green bonds, the possibilities for investment must be evaluated. As we noted in the preceding sections of this paper, these proceeds are intended to finance environmentally friendly projects. The results of our research on banking practice show that, presently, banks in Bulgaria finance mainly projects with various aspects of ecological orientation through various products, which can structurally be grouped into the following categories:

- Energy efficiency loans: "Green energy", "Green housing credit";

- Renewable energy sources – loans for photovoltaic power stations, wind turbines, etc. Based on contracts concluded with the electricity distribution companies (EDC) (loan "Green Energy – Free Market," loan "Green Energy – Self-Consumption");
- Environmentally friendly transportation – “Eco Autocredit”.

The results for the banking sector are shown in Figure 3.

Figure 3. Priority areas financed by banks related to the reduction of adverse climate change (%)



Source: author’s own elaboration.

The graph clearly shows that funding for the "Energy Efficiency" and "Renewable Sources" categories is provided by all 17 banks operating in the country. However, there are certain misgivings regarding the "Environmentally friendly transportation" sector, which is financed by only 33% of the banks in the country. The results show that there are potential opportunities for investing in environmentally friendly projects using the proceeds of green bonds issued in the future. Furthermore, a comparison of the results related to the first and second objectives of this study reveals that green bonds are an essential tool for raising funds to be invested in such projects.

4.3. Results related to the third objective: Assessment of the choice for investing the proceeds of green bonds with a view to realising the maximum expected return on investment

The focus of this section of the research is on the empirical data regarding the bonds issued in 2023, particularly concerning the bank with the highest absolute issue value, UniCredit Bulbank. For the purposes of analysis in this part of the study, we assume that the whole amount of proceeds of bonds issued in 2023 (BGN 1,401,400.00 thousand) is from green bonds. The bank is required to invest these proceeds in environmentally friendly projects, with the bank's aim being to achieve maximum return on its investment (profit) while adhering to predetermined minimum thresholds for the various types of such investments. The constraint in this case is that investments must not exceed the total amount of proceeds of green bonds, i.e. BGN 1,401,400.00 thousand. For the purposes of mathematical modelling, let's assume that these proceeds will be used to buy a portfolio of green bonds issued by two non-banking institutions (issuers) with the characteristics shown in Table 2 below. As the data in the financial statements of banks are presented in thousands of BGN, for the purposes of calculations, the figures in the table related to the market price and yield of the green bonds are also presented in thousands of BGN.

Table 2. Invested proceeds of green bonds

Issuer	Minimum investment threshold	Green bond's market price (BGN thousand/bond)	Expected return (yield) (BGN thousand/bond)
Issuer 1	Not less than BGN 250,000 thousand	1.15	0.30
Issuer 2	Not less than 350,000 thousand	1.80	0.25

Under these constraints, the linear optimisation model will be (adapted from Gocheva-Ilieva & Kulina, 2019, pp. 125-165):

Target function:

$$Z(X) = 0.3x_1 + 0.25x_2 \rightarrow max$$

Constraints:

$$1.15x_1 \geq 250{,}000$$

$$1.80x_2 \geq 350{,}000$$

$$1.15x_1 + 1.80x_2 \leq 1{,}401{,}400$$

$$x_1 \geq 0, x_2 \geq 0$$

The results from this optimisation model will allow the banks:

- to assess the feasible investment options while adhering to the provisions regarding the investment of proceeds of green bonds;

- to determine the optimal structure of the portfolio (i.e. how many bonds from each issuer it should contain to maximise the bank's profit).

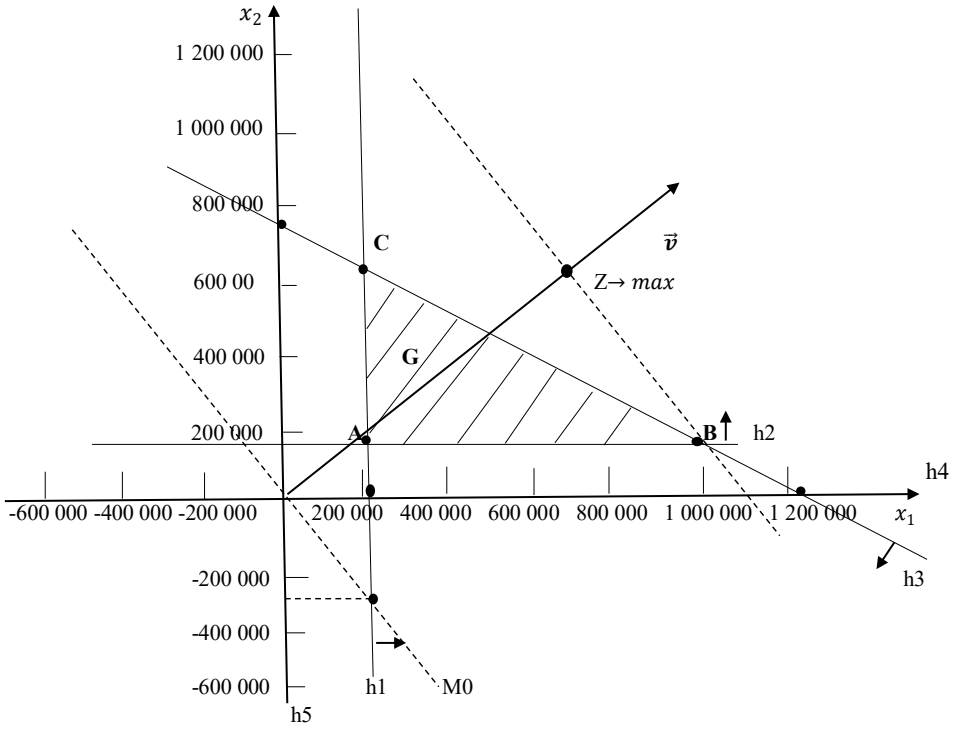
To present graphically the solutions of the model, the system of linear inequalities should be transformed into equations, with each equation representing a line in the plane (h) that divides the plane into two half-planes.

h1:	$1.15x_1 = 250{,}000$
h2:	$1.80x_2 = 350{,}000$
h3:	$1.15x_1 + 1{,}80x_2 = 1{,}401{,}400$
h4:	$x_1 = 0$
h5:	$x_2 = 0$

The condition for the non-negativity of parameter x_j implies that the graphical representation of the solutions must be confined to the first quadrant of the Cartesian coordinate system. To achieve this, a line is constructed in the plane using the coordinates of two points, using a test point with coordinates x_1 and x_2 equal to 0. Thus, for example, the line of equation h3 is determined by the points with coordinates (0; 778,556) and (1,218,609; 0). By substituting the coordinates of the test point into inequality h3 confirms the feasibility of the constraint, which means that the potential investment solutions lie beneath the line of equation h3. This means that the solutions of the systems will be the intersection points of the lines corresponding to equations h1 and h2 with the line for equation h3. Consequently, the calculations yield the following results: for h1: (217,391;0), for h2 (0; 194,444) (see Fig. 4). The intersect points with coordinates **A** (217,391; 194,444), **B** (914,262; 194,444) and **C** (217,391; 639,666) delineate the region of admissible solutions G. Any point within region G will represent the corresponding quantity of green bonds of the two issuers the bank may buy at a given market price using the proceeds of the green bonds it issued. For example, an arbitrary point with coordinates for x_1 and x_2 (400,000; 500,000) within region G indicates that the bank could purchase the corresponding value of green bonds from each issuer (i.e. 400,000 from Issuer 1 and 500,000 from Issuer 2) at the given market prices, or a total value of BGN 1,360,000 thousand, without exceeding the amount of the proceeds of BGN 1,401,400.00 thousand of its own green bonds.

In order to determine the optimal structure of investments that would maximise profit, it is essential to identify the points at which the target function achieves its extremum (maximum). Using the coefficients of the variables of the objective function, we plot the vector $\vec{v}$ directed to its extremum (maximum). The line representing level 0 is denoted as M0. This line is perpendicular to the vector, and its displacement in the direction of the vector delineates the maximum of the objective function, achieved at the intersection with the point of greatest value within the region of permissible solutions G. As illustrated in the figure, this point is **B** (914,262; 194,444).

Figure 4. Region of acceptable options for investing the proceeds for a given market price and yield



Thus, when the coordinates of point **B** are replaced with the variable of the target function, we get:

$Z(914{,}262;\ 194{,}444) = 0{,}3 * 914{,}262 + 0{,}25 * 194{,}444 = 274{,}279 + 48{,}611 = 322{,}890$

It should be noted that the model is based on a simplified scenario, assuming constant yields and market stability. In practice, investment decisions are influenced by additional factors such as credit risk, regulatory compliance, liquidity preferences, and macroeconomic uncertainty.

The results lead to the conclusion that, considering the market value and yield of the green bonds of each issuer, the investing bank will maximise its profit by acquiring 914,262 green bonds from Issuer 1 and 194,444 green bonds from Issuer 2.

5. Limitations

This study is based primarily on publicly available financial data from 2022-2023 and hypothetical modelling of investment scenarios. The analysis does not incorporate qualitative insights from stakeholders or dynamic financial simulations. As such, the results should be interpreted as indicative rather than predictive. Future research could benefit from sensitivity analysis, stakeholder interviews, and market scenario stress testing.

6. Conclusion

The results of the conducted research demonstrate that, as part of the global financial market and in line with international economic trends, banks operating on the territory of the Republic of Bulgaria have developed and implemented an investment policy aimed at improving the climate. The existing investment opportunities in this field indicate that it is reasonable for banking institutions to include the issuance of green bonds as a mechanism for accumulating financial resources to be invested in environmentally friendly projects. The similarity between the mechanisms of green bonds and conventional and covered bonds, as well as the fact that the latter two types of bonds are used as instruments for resource accumulation by more than 40% of the banks in Bulgaria, suggests that green bonds can be integrated seamlessly into the structure of banks' borrowed capital. Although these securities and the financial resources accumulated through them are essentially intended for the benefit of society as a whole, the banks in Bulgaria, being commercial enterprises, must operate in this field while maintaining an optimal balance between risk and expected return. Using economic analysis methods combined with established mathematical models, a comprehensive assessment was made of the banks' readiness to use green bonds as yet another instrument for accumulating financial resources. However, the readiness to issue green bonds may vary significantly among institutions, depending on internal expertise, regulatory compliance capabilities, and access to investors interested in green debt instruments. By maintaining a moderate balance between expected risks and returns through subsequent investment of the accumulated financial resources in green bonds, banks simultaneously become a reliable business partner and a factor for sustainable development and economic growth.

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