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Segmenting SMEs in Central Europe's coal mining region based on green finance awareness

1. Introduction

The global shift toward sustainability necessitates unprecedented financial commitments. According to the European Commission, at least €1 trillion in sustainable investments will be needed over the next decade. At least 30% of that amount will be dedicated to climate-related problems (Fetting 2020). Additionally, the United Nations Climate Change Conference 2022 concluded with a decision to phase out coal mining, necessitating the transformation of mining regions. The green transition is a global movement towards a more sustainable future, and Central Europe is no exception. The countries in this region face unique challenges when it comes to financing the green transition due to their economic history and current political landscape. Given the scale of the challenge, it is crucial to engage the private sector, particularly small and medium enterprises (SMEs), in the transition towards a greener economy.

Central and Eastern Europe (CEE) regions, in particular, are facing significant challenges in financing the green transition due to a variety of factors, including the economic and political context, institutional frameworks, and market conditions. In that theme, green financing refers to the process of providing capital to finance environmentally friendly projects. This type of financing is becoming increasingly popular as countries and regions move towards sustainable development (SD). SD is defined as development that meets the needs of the present

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without compromising the ability of future generations to meet their own needs (World Commission on Environment and Development, 1987). The Sustainable Development Goals (SDGs) were adopted by the UN General Assembly in 2015, but they are not legally binding like the climate agreement. Therefore, in the same year, the international community created a new climate agreement in Paris. The SDGs are important for the 2030 Agenda, which guides global environmental and development policy, but their goals can be unclear. The Paris Agreement, on the other hand, has clear goals and assumptions, with the main aim being to limit the increase in Earth's temperature to below 2 degrees Celsius compared to pre-industrial levels. The importance of the problem also increases with the introduction of the European Green Deal (EGD) which aligns with the objectives of the Paris Agreement and SDGs (Liobikienė, Miceikienė 2023).

Unlike SDGs that cover a wider range of global development goals including social, economic, and environmental aspects, the EGD places focus on policies related to climate change in the European context. EGD outlines specific targets such as greenhouse gas emissions reduction by 2030, decarbonization of the energy system, and making Europe climate neutral, meaning net-zero greenhouse gas emissions (Fredriksson, Zachmann 2021; Lapčík et al. 2022). It requires substantial funding and policy instruments to reach its ambitious targets, it is contingent on factors such as EU budget negotiations, national governments approval, and mobilising private sector capital investment (Busse et al. 2021; Filipović et al. 2022). The Deal also impacts many sectors, not only those related to energy consumption and utilisation, but also agriculture by aiming to reduce the use of pesticides and promoting organic agriculture (Pańka et al. 2021). Regardless of the chosen targets, the effect of the EGD reaches numerous sectors, many areas of life, and economic activity, posing a major challenge for CEE economies.

In this context, regions, cities, and especially SMEs are pivotal. SMEs are considered as the backbone of the European economy, accounting for 99% of all businesses in the EU and employing around 100 million people. According to the OECD (2020), increasing spending and matching investment pathways by 2050 within climate neutrality goals should be an important part of the transformation process. Reducing carbon dioxide emissions is clearly beneficial for the environment, but it can have a negative impact on the economy. Therefore, it is important to study the sources of financing for the green transformation and analyse the potential effects of policy actions on both the environment and the economy. The financial sector can play a vital role in achieving climate goals and implementing applicable regulations, which is why it has been emphasised in the key assumptions of the Paris Agreement. We consider that research in this area is crucial, as it can lead to insights that can guide policymakers and financial institutions in

supporting SMEs in their green transition efforts (Alsaleh et al. 2021; Bhattacharyya 2022; Cifuentes-Faura 2022).

While existing studies have explored the influence of green finance on businesses, a gap remains in the literature regarding the segmentation of SMEs based on their attitudes toward green finance and their financial situation. This topic is particularly relevant for coal-intensive CEE regions, offering a path to address local environmental issues, support energy transformation, and foster sustainable regional development. Moreover, alignment with EU policies provides additional opportunities for funding pro-environmental projects, further accelerating their transition. This paper seeks to address this gap. Our aim is to investigate the awareness of green finance tools among SMEs, leading to the following research question: How does awareness of green finance tools vary among SMEs, and what are the differentiating characteristics between companies with diverse approaches to green financing? To answer this, we first conducted a literature review on green finance sources and then proceeded with the identification of SME segments based on similarities and differences.

2. Literature background

The transition toward a sustainable, low-carbon economy has become a central challenge for businesses of all sizes. SMEs while representing a crucial part of the economic structure and employment, face unique challenges in this process. This section aims to provide an overview of the main factors influencing SMEs' participation in the green transition, the availability of green finance instruments, and the existing research gaps identified in this field.

2.1. Challenges and drivers for SMEs in green transition

SMEs significantly impact the environment in different ways. It could be emission pollution, discharges to rivers and seas, waste production, and soil contamination. Despite their considerable contribution to global carbon emission, according to studies, SMEs also face limitations in financial resources (Chien et al. 2021; Wang et al. 2023) as well as a lack of knowledge, skills, and experience necessary to address environmental issues effectively (Ghazilla et al. 2015; Journeault et al. 2021). These barriers extend beyond financial constraints and are also related to regulatory barriers (Chien et al. 2021) and the lack of management commitment to implementing green practices (Karuppiah et al. 2020; Khan et al. 2023). This reluctance can be driven by the uncertainty of the economic benefit of it (Khan et al. 2023) which leads to the conclusion about the importance of expertise

required to implement green initiatives (Ghazilla et al. 2015; Wang et al. 2023). Beliefs about the justification of the actions taken also play an important role. Lack of understanding, perceived benefits, and supply chain complexities hinder SMEs' engagement in managing carbon emissions and adopting environmental management systems (EMS). It is shown in the example of UK SMEs' scepticism in the work of Afolabi et al. (Afolabi et al. 2023). It seems that companies of this size view environmental investments as a cost rather than an investment. SMEs encounter difficulties because they have limited awareness of the impact and benefits linked to sustainable investment (Journeault et al. 2021).

However, despite their demanding requirements, green investments can also bring benefits to businesses. Starting with the stream of literature that promotes sustainable economic growth (Sulaksana 2022), Green Entrepreneurial Orientation has a positive influence on not only environmental impact but also on financial performance (Liu et al. 2024; Meng, Hao 2024). This can be framed within the context of dynamic capabilities that foster exploitation of new ideas and catch potential opportunities (Jiang et al. 2018). It promotes the advancements in technology to make it clean and energy-efficient (Jaiwant, Kureethara 2023). Its impact is also shown as significant in the context of SMEs in developing countries. The impact of green financing on SMEs in developing countries, as highlighted by Asad et al. (2023), correlates positively with financial literacy and contributes to green economic recovery, as noted by Hou and Fang as an example of China's economy (Hou, Fang 2023). The questions in that place could be related to the factors that drive the green practices from the SMEs' point of view. Management commitment is consistently identified as a key internal factor, alongside external pressures such as regulation, cost considerations, organizational mission, and consumer pressure (Ha et al. 2024; Lutfi et al. 2023; Subramanian, Suresh 2023; Tyler et al. 2024). Empirical evidence on examples of Canadian SMEs together with interviews highlight the individual values and internal and external interpersonal connections and social environment that influence SMEs' involvement in sustainability initiatives (Westman et al. 2019). The view of SMEs as social actors highlights the importance of relationships and awareness of sources of financing that support green transformation initiatives. In general opinion, SMEs often focus on low-cost, low-tech products to emphasise the attraction of low prices (Awaluddin et al. 2021), but green initiatives can also be an answer to consumer needs (Hafish et al. 2024).

2.2. Availability of green finance instruments

The extant literature presents the possibilities of green finance instruments, however, most of the papers are focused on energy policy and climate policy, as stated by Zhang et al. (Zhang et al. 2019), who provide an extensive bibliometric

analysis on the green finance topic. Another review was done by Akomea-Frimpong et al., who conducted a review focused on green finance in the banking sector, identifying seven main categories: green loans/bonds, green investment, climate finance, green infrastructure bonds, green insurance, green securities, and carbon finance (Akomea-Frimpong et al. 2022). Berrou et al. present the main types of green finance products and services (Berrou et al. 2019). The most innovative were classified as Green Bonds which are instruments that are used to finance specific projects with positive environmental impact. This product is to be used by international financial organisations, large corporations, banks, and even national governments and municipalities, but not SMEs, which are the centre of interest of this article. Green Loans represent the next most common green finance product, dedicated to smaller-scale investments and widely offered by commercial banks. While they require substantial screening and disclosure, green loans are considered the most accessible instrument for smaller entities. The next presented instrument is Green Project Financing Operations, it involves a number of equity investors (the sponsors) and a pool of banks or other financing institutions (the syndicate). It is used for large, long-term investments. There are no guidelines on what can be considered a "green", it only deals with the sponsors and the syndicate. There are also some private green products, the most significant of which is private equity (PE). Private Equity green investing is driven by a need for new value-creation sources and increased risk management, and is characterised by investor engagement. Unfortunately, the potential of PE is not fully realized in the regions relevant to our research, although continued long-term growth is expected (Poświata et al. 2022). Regardless, PE is unlikely to be a primary source of green transition funds chosen by SMEs.

2.3. Research gap and contribution

This paper is linked to a stream of literature focusing on the corporate capital structure, and sustainability issues represented mostly by the global requirements for the green transition and fiscal policy of relevant countries. Key inspirations include the work of Akomea-Frimpong et al. (Akomea-Frimpong et al. 2022), who explore banking green finance and identify research gaps, and Lee and Lee (Lee, Lee 2022), who analyse the effect of green finance on total factor productivity in China. Zhang et al. provide a valuable bibliometric analysis of the field (Zhang et al. 2019). To the best of our knowledge, no authors have focused specifically on the Central European region, taking into account their coal mining and heavy industry historical background. Moreover, according to our knowledge, the SMEs' awareness of potential financial sources for the green project has not been examined before, therefore we aim to contribute to the current literature on

the availability and use of green finance sources/instruments by SMEs. There is no doubt that it is important to make urgent efforts to support investments in projects aimed at these actions related to green transforming regions and cities. During the study of relevant literature, we identified a knowledge gap concerning the source of finance for green projects in the Czech Republic, Slovakia, as well as in Poland. There are some papers targeting each country separately that we identified: Laskowska, for example, focuses their research to Poland but limiting it to only 2 banks is not sufficient in our opinion (Laskowska 2018).

The exploratory nature of this study, coupled with resource constraints and sample availability limitations, led us to concentrate the geographical scope on the Upper Silesian Coal Basin (USCB) in Poland. This specific concentration is justified by the dominant and unique role of the Polish coal sector in the European Union (EU) and Central and Eastern Europe (CEE), where the Polish section of the historical coal region constitutes the largest physical area of the coal basins. Also the Polish economy remains significantly more dependent on coal extraction and consumption than the economies of the Czech Republic and Slovakia. Statistical evidence (Eurostat 2025) clearly reflects this reliance: Poland accounted for 97% of the total EU hard coal production (44 million tonnes), and along with Germany was responsible for almost two-thirds of its consumption (43%). Furthermore, Poland was the second-largest consumer of brown coal (lignite) in the EU (21%), after Germany (46%). Therefore, focusing on the USCB allows this exploratory study to examine the region facing the most immediate and complex economic and social challenges within the EU's climate policy framework, making it the most appropriate area for an in-depth analysis.

3. Research design

We formulated the following research question: "How does awareness of green finance tools vary among SMEs, and what are the differentiating characteristics between companies with diverse approaches to green financing?". This question was addressed by conducting a tailored survey to assess SMEs' readiness for green financing and their financial health. The analysis aimed to determine the similarities and differences between companies with varying levels of green finance awareness and overall financial strength, thereby allowing us to create distinct market segments of SMEs from coal mining regions. The detailed methodology is presented below.

The survey aimed to assess the green finance awareness of SMEs, as well as to identify differences between companies in terms of their financial health and engagement in sustainable investments. The questionnaire comprised seventeen

closed-ended questions divided into two main thematic sections. The first section, Awareness and Level of Engagement with Green Financing (ten questions), focused on key aspects such as general knowledge of green finance instruments, assessment of current implementation, future intentions, and barriers to access. The second section, Financial Health and Business Performance (seven questions), examined the firms' financial stability and overall performance indicators. The full set of questions as an element of cluster analysis is presented in Table 3. The survey was conducted as part of the ExCORE project, a collaborative initiative between young researchers from the University of Economics in Katowice, VSB Technical University of Ostrava, and the Technical University of Kosice. The project focuses on the green transition of coal-intensive regions, with specific emphasis on economic consequences, social implications, energy poverty, and the implementation of new technologies (Funding: The Polish National Agency for Academic Exchange (NAWA) Strategic Partnerships Programme, Project No. BPI/PST/2021/1/00007).

The data was collected from 200 Polish companies operating in the Silesian region in 2023. As shown in Table 1, 61% of firms are classified as small firms in terms of the number of employees, the remaining 39% of companies are considered to be medium-sized. The largest representation is of service-oriented companies (46%), followed by production companies (39.5%) and finally business companies (14.5%). Family-owned firms dominate the sample (61%).

Table 1

Sample structure

Category	Group	Share [%]
Business form	Limited liability	56.5
	Partnership	6.0
	Other	37.5
Main business profile	Service	46.0
	Production	39.5
	Business	14.5
Number of employees	10–49	61.0
	51–100	23.0
	101–150	4.0
	151–200	7.0
	More than 201	5.0

Table 1 cont.

Category	Group	Share [%]
Energy costs (% of total operating costs)	1–10	57.0
	11–20	28.0
	21–30	8.0
	31–40	5.0
	41–50	1.0
	More than 51	1.0
Family business	Yes	61.0
	No	39.0

Before creating the SME segment based on their attitudes towards green financing, factor analysis was first applied, which allows the variables to be reduced to a few factors before performing the cluster analysis, which can be named and described. Factor analysis does not distinguish between dependent and independent variables, but rather deals with the interdependence between variables. When used for market segmentation, the analysis helps identify variables that can be used to divide customers into individual groups (Aljandali 2017).

To apply factor analysis, certain conditions must be met. The first is Cronbach's Alpha, which measures the consistency and reliability of individual items on the scale and their relationship to the battery. Its value should be above 0.7 (DeVellis, Thorpe 2021). The next condition is the KMO Index, which assesses the suitability of factor analysis and should be between 0.5 and 1.0. Values lower than 0.5 indicate that factor analysis is not appropriate. The last test before using factor analysis is Bartlett's test of sphericity. This shows whether factor analysis can be performed with regard to the correlation of variables. The null hypothesis (H0) is defined as there being no correlation between variables. The alternative hypothesis (H1), on the other hand, states that there is a correlation between variables. For the purposes of factor analysis, a variable can correlate with itself, but it should not correlate with other variables (Malhotra 2017).

There are several methods of factor analysis, namely principal component analysis, the least squares method, or common axis factoring. The factors can then be rotated using Varimax orthogonal rotation, and in this rotation, each original variable tends to join with one (or a small number of) factors, and each factor

consists of only a small number of variables. The factors generated by this method are easier to interpret (Abdi 2003). The final number of factors can be determined by Eigenvalue, also known as Kaiser's rule. Eigenvalue is a value that represents the total variance explained by individual factors. According to Kaiser's rule, those factors with an Eigenvalue greater than 1 are determined as final factors, which was used as a basis for this project (Malhotra 2017).

The second used method is the cluster analysis, which classifies objects into groups based on their similarity. Objects within a single cluster are more or less homogeneous and differ from objects in other clusters. According to this analysis, each object belongs to only one cluster, and these clusters do not overlap (Hennig 2015). Clustering methods are divided into hierarchical and non-hierarchical methods. One of the hierarchical clustering methods is Ward's method, which, compared to other methods, produces compact, relatively small clusters of roughly equal size (Everitt et al. 2001). Important are methods of distance measurement between the clusters, one of the most common is the Euclidean distance, which is the square root of the sum of the squares of the distances between the coordinates of the objects (Bouhmala 2016).

The second approach is called non-hierarchical clustering. In this case, the number of clusters is known, and other objects are gradually accumulated towards the centre of each cluster. One of the non-hierarchical clustering methods used is the K-Means method, which starts with random centres that are recalculated until their position is stable. Objects are assigned to the cluster whose centre is the closest to them (Malhotra 2017).

4. Results

To enhance the clarity and comprehensibility of the findings, the results section is divided into subsections presenting the main stages of the analysis, including factor analysis, cluster analysis, and the description of the identified segments.

4.1. Factor analysis and dimensionality reduction

Prior to cluster analysis, which was used to create segments of companies in the green finance market, factor analysis was used to reduce the sub-variables of a smaller number of factors. The conditions for using factor analysis were met. The Kaiser–Meyer–Olkin test measuring data consistency showed a value of 0.781, which is above the required value of 0.5. Also, Bartlett's test of sphericity confirmed

that there was a correlation between the variables, the p-value of the test was 0.001 (Tab. 2). Thus, the null hypothesis was rejected, and the alternative hypothesis which claims that the variables are correlated, was accepted (Malhotra 2017).

Table 2

KMO and Bartlett's test results

Indicator		Results
Kaiser–Meyer–Olkin measure of sampling adequacy		0.781
Bartlett's test of sphericity	approximate Chi-Square	1489.556
	degrees of freedom	136
	significance	<0.001

The extraction method used was Principal Component Analysis. The factors were subjected to Varimax rotation, a process that facilitates interpretation by maximizing the loadings for a single variable within a given factor (Abdi 2003). The number of factors was determined by the Eigenvalue, according to this rule the final model included the components whose variance (eigenvalue of the correlation matrix) is greater than 1, which was by five factors. As shown in Table 3, the 17 original variables were reduced to five outcome factors. According to Hair et al. (2009) for the sample size of 200, factor loading higher than 0.4 is considered to be significant. Therefore, two statements had cross-loadings and one had two significant cross-loadings. Following the suggestion of Dang and Pham (2022), these variables were retained as they indicate a dual effect on different factors. Each variable was ultimately assigned to the factor for which the loading coefficient was higher. These reduced variables then served as the input factors for the subsequent cluster analysis.

Table 3

Rotated component matrix with factor loadings

Survey question	Component				
	1	2	3	4	5
1.05. We know how to apply for green financing instruments	0,806	–	–	–	–
1.03. We sought expert financial advice on the green financing options available to our company	0,789	–	–	–	–

Table 3 cont.

1.02. We know the benefits of using green financial instruments	0,784	–	–	–	–
1.01. We believe that we are well-informed about the different types of green financial instruments	0,775	–	–	–	–
1.04. We have received support and information on financing options for our company's green transformation process from external parties	0,756	–	–	–	–
2.05. Our company maintains liquidity at a good and stable level	–	0,890	–	–	–
2.04. Our company remains viable (profitable)	–	0,872	–	–	–
2.06. The overall financial situation of our company is good	–	0,863	–	–	–
2.07. We are satisfied with the operating profit margin achieved	–	0,698	–	–	–
1.08. We plan to use green financial instruments in the future	–	–	0,828	–	–
1.06. We believe that green financing instruments are essential to maintain competitiveness in our sector	–	–	0,765	–	–
1.07. Green financing is more costly compared to standard	0,330	–	0,639	–	–
2.02. We have increased our market share	–	–	–	0,850	–
2.01. We have increased the number of employees	–	–	–	0,839	–
2.03. Our sales revenues have increased	–	0,494	–	0,621	–
1.09. We have encountered difficulties in finding suitable green financial instruments that are in line with the specific needs and objectives of our company	–	–	–	–	0,818
1.10. We believe that our company is excluded from green financing opportunities	–	–	–	–	0,776
Extraction method: principal component analysis. Rotation method: varimax with Kaiser normalization Rotation converged in six iterations					

4.2. Cluster analysis and segmentation

Both hierarchical and non-hierarchical clustering were used to create clusters to compare the two methods. Hierarchical clustering was used first since the number of clusters was not known in advance. Two clusters were created using Ward's method and as a method of distance measurement Euclidean distance was used. The results were also confirmed by a dendrogram and the agglomeration schedule coefficient. For hierarchical clustering, the number of clusters from the previous method was worked with. Due to the sample size, which was 200, hierarchical clustering was preferred, as more equal in size and better interpretable clusters were created by this method. However, both methods produced two well-described clusters. Finally, as it can be seen in table 4, these two clusters were validated using the ANOVA test to confirm whether the mean values of variables for the observed clusters are identical or not. There were identified significant differences regarding the mean values of variables at a significance level of 0.05. The number of clusters can be therefore assessed as correct and confirmed. The newly formed clusters were named according to how firms responded to statements about their financial situation and to statements regarding their attitudes towards green finance and awareness of these instruments.

Table 4

ANOVA test between created companies segments in the green finance market and five reduced factors

Segments		Sum of squares	Degrees of freedom	Mean square	F	Significance
1) Awareness and interest in green finance	between groups	28,426	1	28,426	32,997	0,000
	within groups	170,574	198	0,861	–	–
	total	199,000	199	–	–	–
2) Liquidity, profitability and margin (financial company growth indicators)	between groups	36,746	1	36,746	44,842	0,000
	within groups	162,254	198	0,819	–	–
	total	199,000	199	–	–	–
3) Potential and future use of green finance	between groups	4,135	1	4,135	4,201	0,042
	within groups	194,865	198	0,984	–	–
	total	199,000	199	–	–	–

Table 4 cont.

4) Market share and employees (other company growth indicators)	between groups	37,899	1	37,899	46,579	0,000
	within groups	161,101	198	0,814	–	–
	total	199,000	199	–	–	–
5) Difficulties and unavailability of green finance	between groups	8,700	1	8,700	9,052	0,003
	within groups	190,300	198	0,961	–	–
	total	199,000	199	–	–	–

4.2.1. Segment 1: passive idealists

The first segment, labelled passive idealists, included 47% of the surveyed firms. 70.2% of this segment are medium-sized firms and 29.8% are small firms. According to their self-assessments (Fig. 1) their level of awareness of green financial instruments is not that high (48.17%) and so is their knowledge of the benefits of using these products (48.50%). They also did not seek much expert advice on this topic (29.67%) and did not receive much information about their options for green transformation (24.83%).

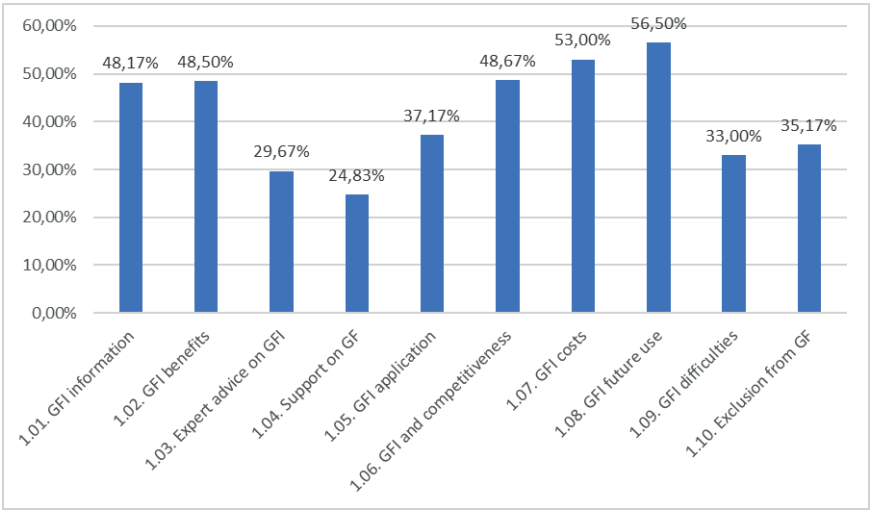

Figure 1. Passive idealists cluster green finance statements agreement rate

Moreover, regarding their self-evaluation of financial situation (Fig. 2), it is perceived very positively – their company is evaluated as profitable (82.50%), their liquidity is said to be at a stable level (80.50%), and they are not in threat of

bankruptcy (82.33%). Their market share (30.83%) or the number of employees (27.33%) did not increase as much as they are mostly small companies. They are also quite satisfied with their operating profit margin (62.50%).

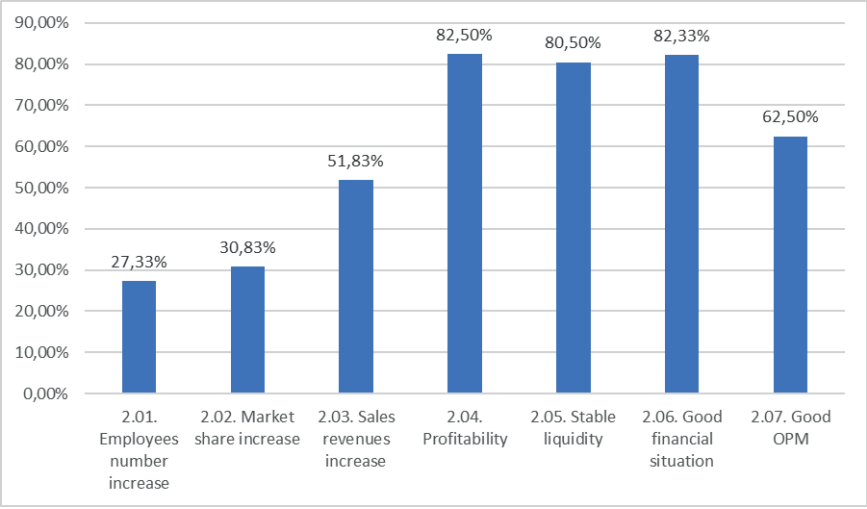

Figure 2. Passive idealists cluster financial situation agreement rate

4.2.2. Segment 2: informed realists

The second segment of so-called informed realists consists of 54.7% medium-sized companies, 45.3% small companies. It also consists of more family companies (63.2%) than the first segment (58.5%). This segment (Fig. 3) is better informed about green finance instruments (58.67%) and also about their benefits (61.17%). Some of them have already sought expert advice (49.83%) and informed themselves about applications for green finance instruments (53.50%). They are more engaged in this topic, so they found some difficulties in finding suitable instruments for their company specifically (45.83%).

Regarding the financial situation that companies themselves evaluated (Fi. 4), it is also rated quite positively but they are not as idealistic about it as the previous segment. They managed to increase the number of their employees (42.33%), including their market share (53.17%). Companies from this segment also evaluate their profitability relatively positively (64.83%), their liquidity as stable (63.17%) and they also perceive their financial situation quite well (67.00%), however, these areas are not evaluated so optimistically compared to the first segment. In this case, of course, it is a self-assessment of the financial situation

from the perspective of companies, which will not be very objective from this point of view, as companies may tend to overestimate their financial situation.

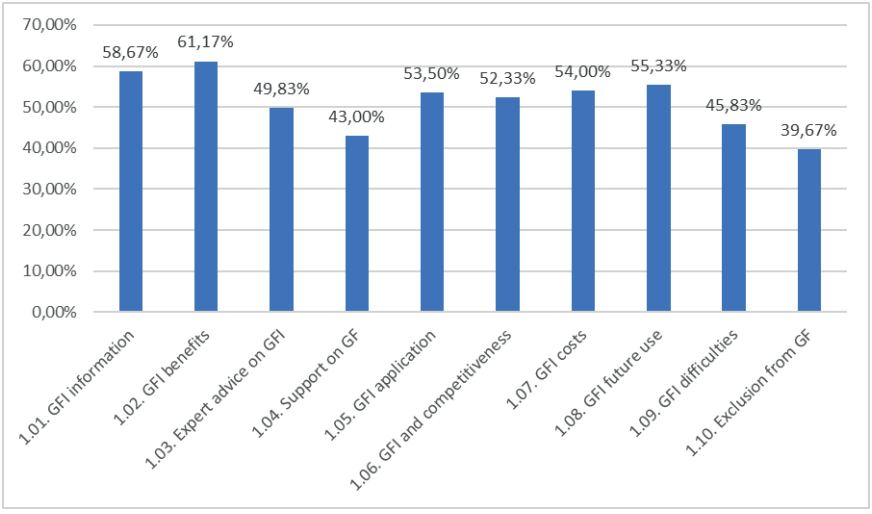

Figure 3. Informed realists cluster green finance statements agreement rate

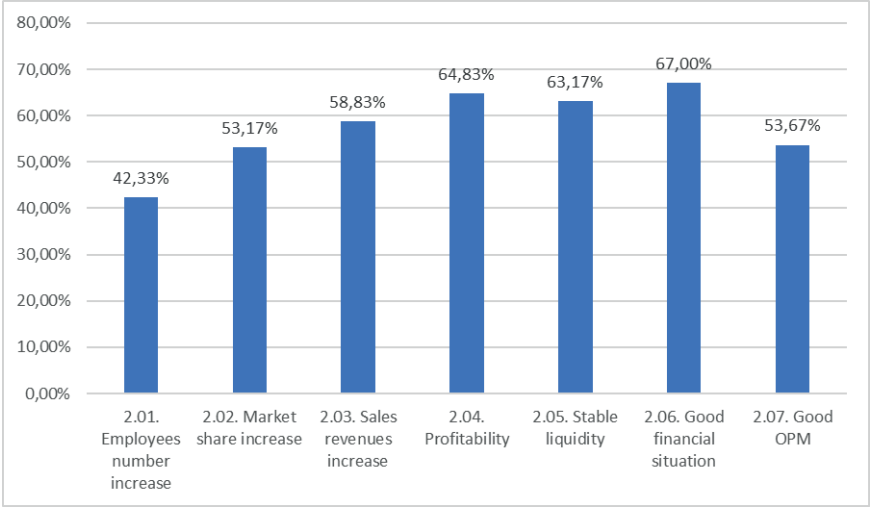

Figure 4. Informed realists cluster financial situation agreement rate

5. Discussion and conclusions

In line with the structure used in the previous chapters, this section is divided into several parts for clarity and consistency. It begins with a summary of the identified segments, followed by a discussion of key challenges and implications for policymakers and financial institutions, and concludes with the study's limitations and suggestions for future research.

5.1. Segment characteristics summary

This paper aimed to explore the awareness and readiness of SMEs in CEE for green financing. By analysing their attitudes towards green financing, alongside other characteristics, the study was able to segment these businesses into categories. Outcomes demonstrate that the segmentation uncovers unique profiles in terms of financial health and involvement in green finance. The first identified group of SMEs – passive idealists show robust financial results with restricted involvement in green finance, whereas the second group consisting of informed realists are more knowledgeable and proactive in green finance, despite facing obstacles, and exhibit favourable yet slightly less robust financial metrics. The two segments show some similarities. The level of agreement is very similar for the statement that green finance is more financially demanding than conventional forms of finance, at 53% for passive idealists and 54% for informed realists. The level of agreement is also similar for the statement that firms plan to use these instruments in the future, at 56.50% for passive idealists and 55.33% for informed realists. The two segments are also fairly unanimous that using these tools increases competitiveness, with 48.67% for passive idealists and 53.33% for informed realists.

However, the segments have different views on several claims. This relates, for example, to statements about whether they have sought expert advice on green finance. For the first segment, the passive idealists, the level of agreement with this statement is only 29.67%, while for the informed realists segment it is 49.83%. There are also significant differences in the statement on whether companies know how to apply for this form of financing. The level of agreement was 37.17% for passive idealists and 53.50% for informed realists. The last statement with a significant difference concerns whether firms received support and information on financing options for their company's green transformation process from external parties. The level of agreement is 24.83% for passive idealists and 43% for informed realists. Although the level of agreement is not as high despite the large difference, it is generally higher for the second segment for all of the three statements compared.

5.2. Green finance challenges and issues

One of the problems associated with green financing of companies is the insufficient support from the state or financial institutions and the need for more awareness of these products. These barriers emerged in the research for both segments created. These results are also supported by the research of Falcone and Sica (2019), who identified some uncertainty about the law in this area. There is a need for more knowledge about green financing options as it becomes a barrier of green financing. Berensmann and Lindenberg (2016) also pointed out the need for more awareness in this area and the ambiguity about the extent of government support. It is especially important at a municipal level where green finance policies can face some limitations (Wang, Gao 2024).

Green financing is also perceived by firms in this study as more costly compared to conventional financing methods, which is also confirmed by work of Schletz et al. (2020) who highlight the high transaction costs. The two segments identified show some knowledge in the areas of green finance, for example, regarding the benefits of using these products. In their research, Ji et al. have shown that these assets outperform conventional assets in terms of performance without taking environmental protection into account (Ji et al. 2021). There is also a certain belief among companies that the use of green financing increases their competitiveness. Flammer points out that the use of green equity leads to better operational performance in firms (Flammer 2018). Also, Hartzmark and Sussman confirm that there is a belief in the positive impact of green bonds on the overall financial performance of an organisation (Hartzmark, Sussman 2019). In the examination of the adoption of green practices, Khandelwal and Singh identified that Indian SMEs demonstrate a favourable attitude towards green manufacturing (Khandelwal, Singh 2022). However, with the existence of disparity between their willingness and preparedness to implement such practices. In contrast, European SMEs, as highlighted by Chatzistamoulou display a greater propensity to involve themselves in sustainability transformations during the digital revolution and view their engagement in public procurements as a driving force (Chatzistamoulou 2023). The relationship between digital transformation and ESG performance, including its impact on green finance and SME reporting outcomes, has become a significant area of research. There are numerous studies highlighting a positive correlation further emphasizing their importance and relevance (Chen, Wang 2024; Zhang et al. 2024).

5.3. Implications for policymakers and financial institutions

The segmentation of firms into passive idealists and informed realists offers important implications for the design of green finance strategies. Passive idealists

are firms that recognize the importance of the green transition, but lack the practical knowledge, resources, or strategic integration to act upon it. For policymakers, this suggests the need to provide simplified reporting frameworks, educational initiatives, and targeted subsidies that lower entry barriers. These firms may benefit from knowledge transfer, environmental finance literacy programs, and demonstrative pilot projects that reduce uncertainty (Hörisch et al. 2020). Financial institutions could engage this segment through standardized green loan products with clear eligibility criteria, or blended finance schemes that de-risk early investments. Such approaches are consistent with evidence that firms' environmental attitudes and financial literacy strongly influence their willingness to adopt sustainable finance instruments (Molina-García et al. 2025).

By contrast, informed realists represent firms that are knowledgeable about green finance mechanisms and are more likely to align sustainability goals with measurable performance indicators and to respond to advanced instruments such as sustainability-linked loans or green bonds. For policymakers, this means that regulation should not only incentivize adoption but also reward high-quality disclosure, carbon reduction performance, and transparent reporting standards (Kelly, Paik 2024). For financial institutions, this segment presents an opportunity to expand customized products and deepen client relationships. Research consistently shows that firms with proactive engagement in green finance enjoy reputational benefits, better capital access, and long-term financial resilience (Liu, Wu 2023).

5.4. Limitations and future research

The main limitation of this work may be shown by the question of how relevant is the assessment of the financial situation when made by the company itself. The assessment of the financial situation in this case is definitely subjective, as it is not evaluated by the financial diagnosis, but by the companies themselves, which may tend to overstate their financial results. Another limitation of the research is the focus on companies operating in the Silesian Voivodeship. Research including companies from other regions of Poland could yield different results, as Silesia has a rich mining history, and due to the transition of these regions, companies may be more inclined to the topic of green financing. Nevertheless, based on the empirical analysis, the authors may consider it both representative and significant.

Future research should address the identified limitation. First, the geographical scope should be extended to other CEE regions (Czech Republic, Slovakia) in order to validate the SME segmentation and provide comparative analysis to other regions. Second, it is crucial to integrate subjective survey data with objective financial data (e.g., from financial statements). However, this would require

a new survey with a smaller sample, as some companies might not be willing to share this data. Lastly, interesting would be conducting longitudinal studies (over time) that would monitor the effectiveness of support policies in activating the passive idealists segment and tracking the transition of firms from declarations to actual pro-environmental actions.

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Summary

The European Commission estimates that at least €1 trillion in sustainable investments will be needed over the next decade. Central and Eastern Europe countries face unique challenges to secure financing for their green transition due to their economic and political background. Among all of the players in the global economy, SMEs significantly impact the environment but face barriers in the adoption of green practices and sustainable investments. Despite the potential benefits of green investments, SMEs often lack awareness and resources to engage in sustainable initiatives effectively. The aim of the research is to investigate the awareness of SMEs of green financing tools. Our focus is set on the identification of similarities and differences between companies and the creation of segments based on different levels of knowledge of green financing and their overall financial situation. The research used a survey-based approach, focusing on SMEs in the Silesian Voivodeship (Poland), a region with a strong industrial heritage and undergoing green transformation. The data was collected from 200 Polish SMEs in the Silesian region and analysed by factor and cluster analysis. Responses were analysed to identify attitudes, levels of awareness, and readiness for green financing. The segmentation reveals distinct profiles regarding financial health and engagement with green finance. It is possible to create two segments of passive idealists and informed realists. Both acknowledged that green investments are more financially demanding. However, the informed realists displayed higher levels of engagement with green financing, including seeking and receiving expert advice and understanding application processes. Limitations include the regional focus and a reliance on subjective self-assessment by firms.

JEL codes: Q56, G32

Keywords: *green finance, SME, European Green Deal, Central Europe, SMEs segmentation*