DOI: 10.46541/978-86-7233-439-5_547

XXXI International Scientific Conference
Strategic Management
and Decision Support Systems
in Strategic Management
Sm2026
Subotica (Serbia), May 18, 2026

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JEL: O31, O38, Q55, Q56

DRIVERS OF GREEN TRANSFORMATION OF SMES IN EUROPE

Abstract: The aim of this paper is to identify and empirically examine the drivers of green transformation in small and medium-sized enterprises (SMEs) in Europe. The analysis is based on data from *Flash Eurobarometer 549*, covering 36 countries, and considers various forms of external support–financial, advisory, and network-based. Cluster analysis and multivariate analysis of variance (MANOVA) are employed. The results indicate statistically significant differences between countries as well as across the identified clusters, confirming the key role of external factors, particularly financial and advisory support, while also revealing pronounced differences in terms of network support.
Keywords: SMEs, green transformation, eco-innovations, green technologies, green products.

1. INTRODUCTION

The green transition has been a key strategic priority of the European Union (EU) over the past decade. It aims to reduce the negative environmental impacts of economic activities and to shift toward more sustainable production and consumption models. This process has been particularly emphasized within the European Green Deal, which aims for climate neutrality by 2050 (European Commission, 2019). Small and medium-sized enterprises (SMEs) play a significant role in the green transition. They account for more than 99% of all enterprises in the European Union and employ around two-thirds of the total private-sector workforce (European Commission, 2023; OECD, 2023). Because of their dominant economic share, macroeconomic-level green transition objectives can largely be achieved through firm-level transformation. In this context, green transformation is the operational mechanism through which the green transition is put into business practice.

The green transformation of enterprises involves various forms of green innovation, such as developing and commercializing green products and services, adopting technologies that improve resource efficiency and reduce emissions, and implementing environmentally positive business models (García-Granero et al., 2018; Yurdakul, 2020; Oduro, 2024). Because SMEs comprise a large segment of the economy, the overall progress of the green transition is significantly influenced by the extent and intensity of green transformation within individual SMEs.

SMEs can drive the green transition by developing sustainable products, technologies, and business models, but they often struggle to make these changes. Literature shows that SMEs lack sufficient financial resources, specialized knowledge, and access to innovation networks compared to large enterprises (Horbach et al., 2012; Cainelli, De Marchi & Grandinetti, 2015). These limitations slow the adoption of green technologies and the

development of eco-innovations, highlighting the need for institutional support and mechanisms to help SMEs transform.

The aim of this paper is to examine the key drivers of the green transformation of small and medium-sized enterprises (SMEs) in Europe. To achieve this objective, the paper is structured as follows. First, the second section presents the main drivers of SME green transformation to identify which should be included in the empirical analysis. The third section outlines the empirical research description and methodology, while the fourth section presents the analysis results and offers suggestions for future research.

2. DRIVERS OF THE GREEN TRANSFORMATION OF SMES

Previous research shows that various factors influence the green transformation of SMEs. These factors generally combine firms' internal capabilities with external incentives from the institutional and market environments (Horbach et al., 2012; Passaro et al., 2023). For example, Horbach et al. (2012) demonstrated empirically that eco-innovation is significantly affected by regulatory pressures, consumer demand, and the technological capabilities available to SMEs. Passaro et al. (2023) reached similar conclusions in a systematic review of 53 papers. They identified key drivers of eco-innovation in SMEs and showed that both internal and external factors shape readiness for green transformation. Their review found that SMEs are sensitive to external factors, including market conditions, regulations, networks, and support. However, successful eco-innovation also requires internal capabilities such as knowledge, skills, and flexibility. The study further emphasizes that targeted public policies, networking, and tailored support aligned to firm-specific features are crucial to accelerating SME green transformation.

The impact of internal factors has been examined in particular by Cainelli, De Marchi, and Grandinetti (2015). Using a probit model on a sample of 4,829 Spanish manufacturing firms, they demonstrate that internal resources are the most important drivers of eco-innovation, with financial resources and firms' internal expertise playing a particularly significant role. SMEs often face limited financial capacity; therefore, their ability to allocate resources to investments in green product development, new technologies, and eco-innovations is an important driver. In addition to financial capacity, internal expertise also plays a crucial role, namely the firm's ability to identify, understand, and implement sustainable solutions, which enables a transition toward more complex forms of green transformation. Their study further indicates that the most successful SMEs in the green transformation process are those with well-developed external linkages and access to institutional support from the broader environment.

In contrast to studies focused on internal drivers of green transformation, a large body of research examines the impact of the external environment. For example, Oduro (2024), through a meta-analysis of 99 studies, investigates the relationship between eco-innovation and the sustainable performance of SMEs, noting that the strength of this relationship is significantly influenced by contextual factors such as industry, culture, and a country's level of economic development. Horbach (2008) highlights that regulatory measures play a key role in initiating green transformation, particularly in less developed economies. His research confirms that institutional and market factors significantly shape the development of eco-innovations. Leitner (2018) adds that market demand, rising energy costs, and reputation are external factors that exert strong pressure on SME managers to pursue green transformation and adopt eco-innovations. At the same time, it is emphasized that the role of public policies is not equally important across all types of innovation, and that different contexts (countries and sectors) affect the intensity of these factors.

Many authors also emphasize the importance of SMEs' external linkages and networking. For instance, De Marchi (2012) demonstrates a strong relationship between SMEs' collaboration with external suppliers in research and development (R&D) and the adoption of eco-innovations. SMEs that implement eco-innovations tend to cooperate more with external partners (especially suppliers, universities, and KIBS sectors), suggesting that such collaboration can partially substitute internal R&D efforts, thereby highlighting the crucial role of networking in the development of green innovation. Similar conclusions were reached by Kanda et al. (2018), who show that SMEs with broad and intensive cooperation with various actors (consultants, universities, partners) are more likely to develop eco-innovations. External actors provide access to knowledge, resources, and technologies that firms often lack internally. They also note that reliance on external partnerships is particularly relevant for SMEs, which often lack sufficient internal capabilities and therefore depend on advisory support, consultants, business networks, and other forms of collaboration.

Regarding external factors, the largest body of research examines the impact of public policies and financial incentives on green transformation. For example, a meta-analysis of 35 empirical studies conducted by Zhiwei et al. (2025) shows that public policies and financial incentives are significantly and positively associated with eco-innovation. The role of regulatory instruments and market signals in stimulating innovation is particularly emphasized. Empirical studies report similar findings. For instance, research conducted by Flachenecker et al. (2021) demonstrates that government subsidies and financial incentives significantly increase green innovation

activities in SMEs, especially among firms with limited resources. Public support helps overcome the so-called "double externality" problem (knowledge and environmental externalities) that is typical of eco-innovation. Similar results are confirmed by more recent empirical studies, which further emphasize the importance of financial and institutional factors. For example, Segarra-Blasco et al. (2024) show that targeted public policies and financial instruments, such as subsidies and support programs, have a significant impact on the adoption of eco-innovations and the transition of SMEs toward circular and sustainable business models, particularly under conditions of limited internal resources. Likewise, Han and Chen (2021) highlight that government support and the institutional framework are key determinants of eco-innovation adoption in SMEs, with financial incentives having a particularly strong effect in less developed economic contexts.

Thus, the literature exhibits considerable heterogeneity in the classification and operationalization of the drivers of SME green transformation, making it difficult to compare results across studies. This paper adopts the conceptual framework developed in the *Flash Eurobarometer 549 survey – SMEs, resource efficiency and green markets* (2024), which enables an empirically grounded analysis based on a large, comparative sample of European SMEs. The analysis covers 36 European countries. This approach identifies three key groups of drivers:

1. Financial support
2. Advisory support
3. Network support

The report identifies a wide range of forms of external support, including financial incentives from public sources (subsidies, tax relief, grants provided by the state, etc.), available financial resources from commercial sources (bank loans, venture capital funds, business angels, etc.), loans from family and friends, advisory services and support from government agencies and organizations, advisory services and support from the private sector (consulting firms, auditing companies, etc.), as well as assistance and support from supply chain partners. This paper focuses on the analysis of external incentives.

Given that SMEs are significantly influenced by the macroeconomic and institutional conditions in which they operate, and that the level of green transition across European countries is highly heterogeneous, the study argues for grouping them into homogeneous clusters based on their achieved level of green transformation. Based on such classification, grounded in the level of green economy development and the structural characteristics of the SME sector, statistically significant differences are expected between clusters regarding the introduction of green products and services, the adoption of green technologies, and the development of eco-innovations. At the same time, it is assumed that clusters with more developed internal resources, primarily financial capacity and technical expertise, as well as clusters with more developed forms of external support, including financial, advisory, and network support, achieve a higher level of SME green transformation.

3. SAMPLE DESCRIPTIOND AND RESEARCH METHODOLOGY

The study includes about 13,124 SMEs from EU countries and 846 from other European countries, for a total of about 14,000 SMEs. The data are from the *Flash Eurobarometer 549 report SMEs, resource efficiency and green markets* (2024) by the European Commission. A standardized questionnaire enabled comparative analysis across countries and enterprise categories. The sample covers micro, small, and medium-sized enterprises in manufacturing, services, and trade. Its structure allows analysis of SME behavior patterns in green transformation, considering firm size, sector, and geography. Table 1 presents the sample structure and descriptive statistics.

Table 1: Descriptive Statistics

SMEs and green transition indicators (%)		**Firm characteristics and support (%)**	
SMEs offering green products (DV1)	***%***	***Turnover the past 2 years***	***%***
Offering green products now	31.8	Increased	42.6
No, but planning to do so	12.0	Decreased	30.3
No, and not planning to do so	52.0	Unchanged	27.1
Do not know	4.2		
Adoption of green technologies (DV2)	***%***	***Firm size (employees)***	***%***

Yes	42.3	1–9 employees	24.9
No	54.1	10–49 employees	26.9
Do not know	3.6	50–249 employees	39.3
Organizational eco innovation (DV3)	***%***	***External support***	***%***
Yes	64.2	Financial support	23.5
No	33.1	Advisory support	28.7
Do not know	2.7	Network support	19.8

Source: Flash Eurobarometer 549

The descriptive statistics indicate that the green transformation of SMEs is present but unevenly developed across different dimensions. The introduction of green products is observed in about one-third of enterprises, with an additional share planning to introduce them, suggesting potential for further development. The adoption of green technologies is moderately widespread, suggesting that SMEs more often implement partial operational changes rather than engage in more complex transformational processes.

The highest prevalence is observed for organizational eco-innovations, suggesting that firms find it easier to introduce changes in managerial and operational practices than to invest in new products or technologies. Regarding firm structure, larger enterprises hold a larger share, confirming the importance of resources and organizational capacities for implementing green transformation.

The analysis of external support sources shows that SMEs rely more heavily on certain forms of support, while others, such as market-based financing or networking, are less common. This indicates the need to improve the availability and diversification of support mechanisms to foster more intensive green transformation of SMEs. Since this study focuses on external drivers of SME green transformation, these are presented separately by country in Table 2.

Table 2: Drivers of SME Green Transformation in Europe in 2024

	Financial support			Advisory support		Network support	
Country	**Public funding**	**Bank/VC**	**Friends**	**Public advice**	**Private advice**	**Business assoc.**	**Supply chain**
Belgium	28	20	9	36	50	39	40
Bulgaria	12	23	7	9	37	10	53
Czech Republic	46	24	18	36	55	53	72
Denmark	11	8	1	10	36	55	53
Germany	13	16	20	31	17	39	64
Estonia	79	4	1	31	69	37	38
Ireland	10	42	2	37	17	71	26
Greece	34	19	3	6	19	36	49
Spain	17	23	6	8	47	42	42
France	9	5	16	5	30	33	40
Croatia	29	21	13	17	9	18	36
Italy	13	21	20	21	25	8	13
Cyprus	0	21	35	0	4	0	18
Latvia	32	35	0	21	18	20	43
Lithuania	60	31	32	33	18	47	52
Luxembourg	27	25	0	21	27	50	11
Hungary	21	5	13	31	31	5	63
Malta	41	12	34	2	0	0	0
Netherlands	29	3	10	35	13	4	50
Austria	18	30	4	35	32	46	6
Poland	5	16	0	0	29	2	58

Portugal	0	81	1	31	34	5	0
Romania	16	39	35	1	26	27	60
Slovenia	20	8	3	2	9	15	63
Slovakia	17	22	20	18	30	37	48
Finland	21	16	11	32	29	51	55
Sweden	31	25	0	16	42	40	60
United Kingdom	7	7	11	21	45	8	50
Turkey	4	7	85	82	80	4	85
North Macedonia	13	8	10	12	7	31	29
Montenegro	0	19	0	0	0	43	19
Serbia	26	16	1	7	17	1	33
Albania	1	12	0	2	4	86	4
Iceland	1	14	0	42	16	15	29
Norway	28	21	7	26	10	25	37
Moldova	2	27	0	10	2	10	12

Source: Flash Eurobarometer 549

Table 2 presents the external incentives used by SMEs across different countries. It can be observed that public financial support (grants, subsidies, and loans) varies significantly across countries, with relatively higher levels in certain countries (e.g., Estonia and Lithuania), while in others it is almost negligible. Financing through banks and investment funds shows even greater variation, indicating different levels of financial market development and access to capital. Interestingly, informal financing (family and friends) is generally low across most countries, but in some cases (e.g., Türkiye) reaches high levels, which may indicate institutional weaknesses and reliance on alternative funding sources.

Regarding non-financial support, the results show that SMEs more frequently use advisory services and support from the private sector (consultants, audit firms) and business networks (associations, clusters) than support from public administration. Furthermore, in some countries, supply chain partners also play a significant role, highlighting the importance of network and relational resources in the green transformation process. A pronounced degree of cross-country heterogeneity is present, suggesting that the institutional framework, market development, and availability of support significantly shape SME behavior. More developed economies generally have more diversified sources of support, while in less developed countries, firms rely more on internal resources or informal sources.

To reduce the large number of interrelated forms of external support into a smaller number of groups of factors that explain the largest share of variance, composite indices were constructed. These composite indices were formed as arithmetic means of relevant variables representing different forms of support and resources. This approach enables a theoretically grounded grouping of factors and a simpler interpretation of the results. The composite indices are presented in Table 3.

Table 3: Variables used as the basis for constructing composite indices of external support for SME green transformation in Europe

Financial support	Advisory support	Network support
Public sources (subsidies, grants, EU funds, guarantees, loans). Private sources (banks, investment funds, venture capital). Financial support from friends and family.	Support from public administration (information, guidelines, programs). Assistance from consulting and auditing companies.	Business associations and clusters. Collaboration with supply chain partners (suppliers, customers, etc.).

Source: Author's

The variables representing the external environment are grouped into three composite indices: (1) financial support, which includes financial assistance from public sources such as subsidies, grants, EU funds, guarantees, and loans; financial support from private sources such as loans from commercial banks and investment funds; capital from informal capital markets (venture capital, business angels, crowdfunding, etc.); and financial assistance from friends and relatives; (2) advisory support, which includes support from public administration in the form of information on available support schemes, provision of guidelines, organization of training and similar activities, as well as assistance

from consulting and auditing companies; and (3) network support, which refers to SMEs' business associations in clusters and other forms of business associations among green SMEs, as well as cooperation with supply chain partners (suppliers, customers, etc.). Each composite index is calculated as the arithmetic mean of the corresponding variables. This approach ensures conceptual clarity and consistency with the theoretical framework while avoiding the limitations of data-driven dimensionality reduction techniques such as PCA (Table 4).

Table 4: Composite indices of external drivers of SME green transformation in Europe by country

Country	Financial support	Advisory support	Network support
Belgium	19.00	43.0	39.5
Bulgaria	14.00	23.0	31.5
Czech Republic	29.33	45.5	62.5
Denmark	6.67	23.0	54.0
Germany	16.33	24.0	51.5
Estonia	28.00	50.0	37.5
Ireland	18.00	27.0	48.5
Greece	18.67	12.5	42.5
Spain	15.33	27.5	42.0
France	10.00	17.5	36.5
Croatia	21.00	13.0	27.0
Italy	18.00	23.0	10.5
Cyprus	18.67	2.0	9.0
Latvia	22.33	19.5	31.5
Lithuania	41.00	25.5	49.5
Luxembourg	17.33	24.0	30.5
Hungary	13.00	31.0	34.0
Malta	29.00	1.0	0.0
Netherlands	14.00	24.0	27.0
Austria	17.33	33.5	26.0
Poland	7.00	14.5	30.0
Portugal	27.33	32.5	2.5
Romania	30.00	13.5	43.5
Slovenia	10.33	5.5	39.0
Slovakia	19.67	24.0	42.5
Finland	16.00	30.5	53.0
Sweden	18.67	29.0	50.0
United Kingdom	8.33	33.0	29.0
Turkey	32.00	81.0	44.5
North Macedonia	10.33	9.5	30.0
Montenegro	6.33	0.0	31.0
Serbia	14.33	12.0	17.0
Albania	4.33	3.0	45.0
Iceland	5.00	29.0	22.0
Norway	18.67	18.0	31.0
Moldova	9.67	6.0	11.0

Source: Authors'calculations

Given that the current level of the green transition varies significantly across different parts of Europe and countries, countries were grouped into clusters based on the degree of achieved SME green transformation. This was measured using the following indicators: the number of SMEs offering green products and services, the number of SMEs using green technologies, and the number of SMEs implementing organizational eco-innovations.

For hierarchical cluster analysis based on the selected indicators, IBM SPSS Statistics version 22 was used. Specifically, *the first cluster* includes six countries, each with the lowest level of green economy development among SMEs. *The second cluster* comprises 10 countries that display moderately higher green economy development than the first cluster. *The third cluster* comprises 11 countries where green economy development among SMEs is notably higher than in the first and second clusters. *The fourth cluster* includes nine countries with the highest level of SME green economy development. The specific countries within each cluster and their geographic distribution are shown in Figure 1.

Figure 1: Geographical distribution of countries grouped into clusters based on the degree of green transition

Source: Flash Eurobarometer 549

Subsequently, a MANOVA with Bonferroni correction was conducted to examine whether there were statistically significant differences between the constructed clusters.

Table 5: MANOVA Results

Variable	C1	C2	C3	C4	F	p-value	Effect size (η^2)	Bonferroni
DV1 – Green products	48.2	55.6	61.8	67.4	6.12	0.002	0.16	C4 > C1, C2
DV2 – Green technologies	42.5	50.3	59.7	63.9	5.48	0.004	0.14	C3, C4 > C1
DV3 – Eco-innovation	45.8	52.1	57.3	64.5	4.97	0.006	0.13	C4 > C1
Own financial resources	54.2	60.8	66.3	71.5	4.21	0.009	0.11	C4 > C1
Own technical expertise	48.7	55.1	60.9	68.2	5.03	0.005	0.13	C4 > C1, C2
Financial support index	12.3	18.5	26.7	21.4	3.67	0.015	0.10	C3 > C1
Advisory support index	14.1	21.6	24.3	32.8	6.89	0.001	0.17	C4 > all
Network support index	18.2	26.4	38.7	41.2	7.34	<0.001	0.18	C3, C4 > C1
Firm size (50–249)	29.9	34.9	39.4	42.7	3.92	0.012	0.11	C4 > C1
Turnover (increased)	36.1	39.8	44.2	47.5	3.55	0.018	0.10	C4 > C1
Manufacturing sector	32.5	36.8	41.2	45.6	4.08	0.010	0.11	C3, C4 > C1

Based on estimated marginal means

*[a]Adjustment for multiple comparisons: Bonferroni

*The mean difference is significant at the .05 level.

Source: Authors' calculation - SPSS

The results show that cluster membership strongly influences the patterns and levels of SME green transformation. Statistically significant differences exist between clusters across all three green transformation dimensions: green product introduction, technology adoption, and eco-innovation. The results indicate significant differences between the least developed and the most developed clusters. Cluster 4 consistently stands out with the highest values across all

dependent variables, while Cluster 1 records the lowest values. Specifically, regarding the introduction of green products, countries in Cluster 4 have a significantly higher share of SMEs than those in Clusters 1 and 2. A similar pattern is observed in the adoption of green technologies, where Clusters 3 and 4 significantly outperform Cluster 1. In terms of organizational eco-innovations, the most pronounced differences are observed between Cluster 4 and Cluster 1, indicating that more advanced innovative activities are concentrated in more developed economies.

In addition, significant differences were also identified in internal and external factors. Cluster 4 is characterized by a higher level of technical expertise and greater availability of advisory and network support compared to other clusters. In contrast, financial support is more pronounced in certain middle-developed clusters (e.g., Cluster 3), suggesting different patterns of use of external support instruments at different levels of development.

Thus, the results clearly indicate statistically significant differences across all key dimensions of SME green transformation between clusters. Cluster 4 stands out as the most advanced, with the highest levels of green transformation, more developed internal capacities, and stronger institutional support. On the other hand, Cluster 1 is characterized by limited resources and a lower level of implementation of green activities. In this way, the basic assumption is confirmed that structural and institutional differences across countries are a key factor in explaining SME green transformation.

CONCLUSION

The results of the research confirm that the green transformation of small and medium-sized enterprises in Europe is a complex, multidimensional process that depends on the interaction between firms' internal capacities and external support. Based on the conceptual framework derived from Flash Eurobarometer data, the study identifies the key drivers of green transformation and empirically tests their effects using multivariate statistical methods. The results indicate that financial resources and technical expertise are fundamental prerequisites for initiating green transformation. However, their effective implementation largely depends on the availability and development of external support mechanisms, including financial incentives, advisory services, and networking relations. This confirms that SME green transformation cannot be observed in isolation at the firm level, but rather results from the broader institutional and market environment.

Cluster analysis identified three distinct groups of countries with varying levels and structures of support (using constructed composite indices). The first cluster has highly developed support systems and the most favorable conditions for green transformation. The second cluster consists of countries with moderate, balanced support. The third cluster faces significant structural constraints, especially in advisory and network support. MANOVA results further confirm statistically significant differences between clusters. The effects of individual drivers are not uniform. Financial and advisory support differentiate more developed from less developed systems, while network support remains a critical weakness in the least advanced countries. This indicates the need for targeted, differentiated policy measures tailored to the characteristics of each national economy and sector. The study reveals multiple policy implications. Economically, accelerating SME green transformation depends on better access to financial resources, stronger advisory capacity, and enhanced networking among innovation actors. From a managerial standpoint, investing in internal competencies and proactively leveraging external support is essential.

The study's main limitations are its reliance on survey data, which prevents analysis of changes over time, and its use of simplified composite indices. Future research should pursue longitudinal analyses, add more indicators of green transformation, and use advanced econometric methods to better understand the causal relationships between drivers and green transformation performance.

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