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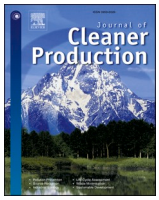

Can we count on the commitment of European SMEs to achieve SGD12? An exploratory study of business sustainability

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ABSTRACT

The United Nations created the 17 Sustainable Development Goals (SDG) to serve as a compass for a better future, i.e., for a sustainable future, a green, socially and financially prosperous tomorrow. Due to the significant responsibility of small and medium-sized enterprises (SMEs) to environmental dilapidation and destruction, they are an essential engine to the green transition. Business activities are central to achieving SDG12. This article focuses on the contribution of European SMEs to carbon neutrality. We explore the influence of SMEs' investment in micro resource-efficiency actions on adopting macro measures of carbon neutrality and whether investments, financial, administrative, and regulatory requirements influence the implementation of resource efficiency practices. This is the first attempt to explore the interrelationship between micro resource efficiency and macro climate change measures. A quantitative analysis was performed using descriptive statistics, factor analysis (exploratory and confirmatory factor analysis) and the partial least squares method. Data from 2021 included 17,144 European SMEs and were retrieved from the fifth wave of the Flash Eurobarometer 498. The results reveal that SMEs' implementation of resource-efficient actions at the micro level positively influenced the adoption of macro-level measures for decarbonization. Furthermore, implementing these micro-measures was positively influenced by business investment and negatively affected by external sources of finance and regulatory and administrative requirements. Overall, the findings indicate that European SMEs still have a long way to go toward the twelfth SDG and decarbonization.

1. Introduction

With 8 billion people in the world today, ecological scarcity has become evident, and environmental deterioration has been growing at alarming and unprecedented rates. According to Global Footprint Network, humanity is currently using the resources of 1.75 planets to provide the goods and services demanded. This means the Earth takes one year and nine months to regenerate what is used in a year. Thus, sustainable development is the only grant for the survival of human civilization. The United Nations created the 17 sustainable development goals to serve as a compass for a better future, i.e., for a sustainable future, a green, socially and financially prosperous tomorrow. However, a substantial part of the SDGs is missing their targets, which is worrying because either they are inefficient or unrealistic or simply nobody knows about them. We all hope that in a future of 9 million people, there will be a world that will allow them to do more than survive.

Resource efficiency is part of the overarching concept of sustainable development due to its contribution to economic development considering environmental conditions. Resource efficiency comprises initiatives to increase material and energy efficiency, facilitating the decoupling of resource use from economic growth (Domenech and Bahn-Walkowiak, 2019). According to Sofuoğlu and Kirikkaleli (2023), sustainability and efficiency in the field of material footprint are, together with reducing emissions from fossil fuels, essential tools to achieve the net zero targets. The authors find that while material footprint has a negative impact on carbon dioxide emissions (CO_2) emissions on developed countries it increases the CO2 emissions in developing countries.

Thus, improving resource efficiency contributes to green growth, which, according to OECD, fosters economic growth and development while ensuring that the natural assets continue to provide the resources and environmental services on which our well-being relies (OECD, 2019).

The resource-efficient Europe flagship initiative is part of the European Green Deal (European Commission, COM/2019/640), the European Unions' growth strategy for a modern, resource-efficient, and

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competitive economy. This commitment was recently reviewed in 2020 with the creation of the New European Bauhaus, which connected the European Green Deal initiative to our living spaces and experience. New European Bauhaus calls on all citizens to image and build a sustainable and inclusive future. Small and Medium Enterprises (SMEs) are crucial in achieving such ambitious targets and supporting the shift towards sustainable growth via a resource-efficient, low-carbon economy. These enterprises constitute an essential part of European economic architecture. According to the Annual Report on European SMEs (Gorgels et al., 2022), in 2022, 99.8% of all European enterprises are SMEs. They are responsible for two-thirds of European Union employment and account for about half of Europes' gross domestic product, and they play an increasing role in adding value to every sector of the economy. Despite their economic relevance, SMEs have a strong environmental impact. Although the individual ecological footprint of SMEs may be low, their aggregate impact can, in some respects, exceed that of large businesses. Indeed, SMEs account for a large part of the worlds' consumption of resources and generation of waste, therefore being responsible for 63% of all CO2 emissions in Europe (Gorgels et al., 2022).

Given the crucial role of SMEs in the European economy and their environmental footprint, achieving a sustainable transition and counteracting climate change will only be possible by giving their business activity a central role. In this regard, the business should redirect its source and manufacture towards resource efficiency improvement practices. European SMEs have to follow cleaner and more sustainable production processes. Cleaner production stresses adopting the best environmental practices in production and operational processes (Fan et al., 2020). Clean and sustainable production is a process modification that minimizes the emission and hazardous waste generated by production operations by reducing raw materials, water, and energy consumption. Following clean production processes based on the efficient use of resources puts SMEs in compliance with the twelfth SDG: 'Responsible consumption and production'. SDG12 aims to ensure sustainable consumption and production patterns. In this context, net greenhouse gas emissions, resource efficiency, and zero waste are planned activities (Glavič, 2021).

At the time being, there is increasing research exploring whether European SMEs are committed to sustainable practices (Chatzistamoulou and Tyllianakis, 2022a; Dey et al., 2022; Moursellas et al., 2022) and the barriers to the adoption of resource efficiency practices in SMEs (Jaramillo et al., 2019; Alayón et al., 2022) namely financing, regulation and administrative burden (García-Quevedo et al., 2020). Therefore, the objective of this study is to explore the influence of investment and financial, administrative, and regulatory requirements on the implementation of resource efficiency practices at the micro level and how these micro-efficiency actions influence the adoption of macro carbon neutrality measures by European SMEs. To this end, a quantitative methodology was applied to a sample collected through a questionnaire promoted in 2021 by Flash Eurobarometer 498 and comprising 17,144 European SMEs. The relationships established in the proposed research model were tested using the Partial Least Square method.

The results indicate that entrepreneurs can commit to adopting resource-efficient actions, even if they recognize the existence of many constraints. However, no study investigates the direct contribution of resource efficiency practices in adopting general measures to reach net-zero (carbon neutrality). In other words, there is no evidence regarding whether engaging in resource efficiency actions can put SMEs on the road to net-zero (will boost net-zero strategies). The term 'net-zero' refers to balancing the amount of greenhouse gas emissions produced and the amount removed from the atmosphere (Blundel and Hampton, 2021).

In this article, we contribute to the extant literature, providing an overview of the path SMEs still have to walk to achieve green growth or reach net-zero with their business activities. Thus, we explore whether European enterprises' adoption of micro measures (at the level of resource efficiency) influences their macro measures practices to reach net-zero, and the factors affecting their adoption and commitment to resource efficiency actions (micro measures to sustainability). We use data from the European Commission, including 17,144 European SMEs related to the fifth wave of the Flash Eurobarometer 498 (European Commission, 2022). Previous wave data were used elsewhere (Özbuğday et al., 2020; Chatzistamoulou and Tyllianakis, 2022a). Thus, by considering both micro and macro sustainability measures, we argue that resource efficiency practices (e.g., water, energy, waste savings, and material recycling) may be enhancers of carbon neutrality measures, translated into adopting and developing new technological solutions to reduce gas emissions. Disruptive technologies within the scope of Industry 4.0 can improve environmental performance towards sustainability (Jamwalet al., 2023). To the authors' knowledge, this is the first study to examine European SMEs' net-zero action enhancers.

It is of utmost importance to identify the drivers of resource efficiency practices followed by European SMEs to identify and implement consistent policy strategies to encourage SMEs' investment in micro-efficient resource actions since adopting micro-resource efficiency practices can drive the adoption of macro green growth measures.This study consists of five sections. The first section refers to the introduction, and the second section contains the literature review with formulation of the hypotheses and presentation of the research model. The third section relates to Methods with a description of the sample, the constructs and items that measure them, and the data analysis. The fourth section contains the results of the descriptive analysis of the SMEs participating in the sample, the constructs included in the research model and the items, measures of reliability and validity of the model obtained after applying the Partial Least Square method and the hypothesis test carried out through from bootstrap analysis. The last section, called discussion and conclusion, discusses the results, theoretical, practical and managerial implications, limitations, future lines of investigation and final considerations.

2. Literature review

2.1. Resource efficiency

Recently, the literature has begun to focus on a resource-efficient circular economy. Within the circular economy, resource efficiency encompasses all initiatives companies undertake to increase materials and energy efficiency (Domenech and Bahn-Walkowiak, 2019). It ensures that natural resources are produced and consumed sustainably, reducing the environmental impact throughout the products' life cycle (UNEP, 2010). In this way, by adopting resource-efficient measures, companies reduce their production costs, increasing their competitiveness and green sales (Van Ewijk, 2018) while contributing to sustainable economic growth and development (OECD, 2019).

Companies' strategic decisions with resource-efficient intend maximising the value of products and materials, reducing waste and/or transforming them into new resources. Products and materials, instead of being disposable, are reusable, repaired, recycled, or refurbished, integrating more environmentally friendly production processes (Özbuğday et al., 2020). For SMEs, saving energy and water, reducing waste, and reusing raw materials are considered initial resource-efficient practices (Garrido-Prada et al., 2021; Cunha et al., 2020). For Chatzistamoulou and Tyllianakis (2022a), resource efficiency activities at the level of companies encompass beyond these initiatives also using mainly renewable energy, trading scrap, and designing sustainable products. However, not all practices are implemented the same way, with waste minimisation being the most likely to be adopted by SMEs, followed by energy saving, redesign of products and services, use of renewable energies, and water saving (Katz-Gerro and López Sintas, 2019).

In addition, several theoretical approaches have shown that adopting environmentally friendly technologies has helped and promoted the implementation of resource efficiency in SMEs (Fadly, 2020).

Technologies reduce the environmental impact by maximising production per resource unit consumed, which is the efficiency of resource-output-inputs (del Río González, 2005; Flachenecker and Rentschle, 2018). Companies adopting environmentally friendly technologies help them implement resource efficiency actions more effectively (Lopez et al., 2019), especially in the initial stages. New technologies are expected to reduce resource consumption by companies, improve the process of recycling and reuse of raw materials, and increase the likelihood of their reintegration into the production process (Bocken and Short, 2016). Moreover, adopting clean technologies contributes to reducing CO2 emissions (Fernando and Hor, 2017). Evidence shows that energy consumption is one of the leading causes of increased CO2 production. Thus, energy efficiency can be one of the solutions for sustainable production and minimisation of environmental impacts (Schipfer et al., 2022). In this regard, companies have focused on reducing their carbon footprint, adopting technologies that increase productivity and promote environmental sustainability (Dey et al., 2020). In this context, we believe that SMEs adopting specific resource-efficient actions promotes the adoption by these companies of macro or more general efforts to neutralise the climate impact that will facilitate the implementation of environmentally sustainable strategies. Therefore, the following hypothesis is formulated:

H1. The adoption of resource-efficient activities at the micro level by SMEs contributes positively to the implementation, by these companies, of macro measures at the level of carbon neutrality - neutral impact on the climate.

2.2. Constraints to SMEs resource efficiency practices

2.2.1. Financing

Previous studies have shown that adopting resource-efficient measures depends on the availability of SME finance and their knowledge about funding sources (Chatzistamoulou and Tyllianakis, 2022a). Indeed, achieving a sustainable economy requires sufficient capital to finance the long-term transition of the real economy, which requires fundamental changes in policies and institutions (Giganti and Falcone, 2022). Green Finance is a novel concept that is discussed to address current environmental issues. Indeed, green finance can play a pivotal role in accelerating the transition to sustainability to create the conditions to guarantee a level playing field between the traditional and green economies (Falcone, 2020). A study conducted in Italy found that although green finance provides an opportunity to achieve environmental benefits in a broader context of environmentally sustainable development, it does not prevent entrepreneurs from facing obstacles related to, for example, the short-term orientation of financial instruments and the limited knowledge of financing options and technical expertise within companies (Falcone and Sica, 2019). Moreover, there is evidence that longer relationship with the main bank foster firms' involvement in green investment strategies to reduce their environmental impact (Falcone, 2018).

The lack of capital to finance SMEs' resource-efficient actions hinders their implementation (García-Quevedo et al., 2020). It was found that dependence on external funding sources from banks or public funds can negatively influence SMEs' implementation of resource-efficient measures (Garrido-Prada et al., 2021; Demirel and Danisman, 2019). By contrast, funding resource-efficient efforts with one's funds, including venture capital, positively influences the implementing these practices (Chatzistamoulou and Tyllianakis, 2022a). SMEs prefer to finance themselves with their own money rather than resorting to external financing because of high initial and indirect costs (e.g., time and human resources) and a more extended payback period that the implementation of resource-efficient measures entails for SMEs, leading them not to want to bear additional financial burdens such as interest and commissions (Rizos et al., 2016). Besides, SMEs often have difficulty obtaining guarantees and other collateral that commercial banks require for granting credit (Hyz, 2011). In this context, we formulate the following hypothesis:

H2. Financing resource-efficient measures with own funds positively influence SMEs' implementation of these measures.

2.2.2. Investment

Implementing resource-efficient practices requires substantial investments. According to Demirel and Danisman (2019), if SMEs want to implement circular activities effectively, at least 10% of their annual revenues must be reinvested. These investments should be directed towards transitioning from linear to circular business models, favouring clean measures and technologies that help implement resource efficiency to guarantee environmental sustainability (Özbuğday et al., 2020). However, SMEs are highly reluctant to make investments directed at resource efficiency. For a greater predisposition of SMEs to invest in this field, companies must be convinced that this investment will pay off. The return can be translated by greater economic performance, greater competitiveness due to the reduction of production costs and a competitive advantage in sales, and may even increase sales due to the environmental quality seal of its products and services (Jové-Llopis and Segarra-Blasco, 2018; Horbach, 2018). The cost reduction that resource efficiency can enable will also allow access to new opportunities in producting and designing of new products and/or services (Özbuğday et al., 2020). In this way, we formulate the following hypothesis:

H3. Higher levels of investment in resource efficiency measures positively influence the implementation of enforcement measures in SMEs.

2.2.3. Regulations and administrative requirements

The regulatory and administrative framework required for implementing resource-efficient measures is one of the main barriers SMEs face (De Jesus and Mendonça, 2018; García-Quevedo et al., 2020). SMEs often feel unable to adopt the specific requirements imposed by the legislative framework, preventing the adoption of environmentally sustainable solutions in their business activities (García-Quevedo et al., 2020). Companies often find it challenging to adapt the regulatory requirements to their company. Indeed, the requirements are complex and difficult to interpret, the initial investment costs and the administrative burden that the transition to resource-efficient productions requires is too high (monitoring, reporting, constant monitoring), and there is even a need to hire specific human resources to implement and supervise the processes (Cainelli et al., 2020; Díaz-García et al., 2020; Mungai and Ndiritu, 2023). In addition, taxes on resources are primarily low, and SMEs prefer to buy cheaper raw materials than incorporate recycled or remanufactured raw materials into their products, which increases production costs (Rizos et al., 2016). SMEs perceive that the difficulty in complying with the administrative and regulatory processes associated with implementing resource-efficient actions is an obstacle to implementing circular economy practices. This obstacle becomes more acute when companies implement more than a resource-efficient activity (García-Quevedo et al., 2020). Therefore, we hypothesize that:

H4. High regulatory and administrative constraints associated with resource-efficient activities negatively influence SMEs' implementation of resource-efficient practices.

The research model shown in Fig. 1 synthesizes the formulated hypotheses.

3. Methods

3.1. Sample and data

The main objectives of this study are to explore whether the adoption of resource efficiency practices by SMEs encourages the adoption of macro decarbonization measures and whether the level of investment,

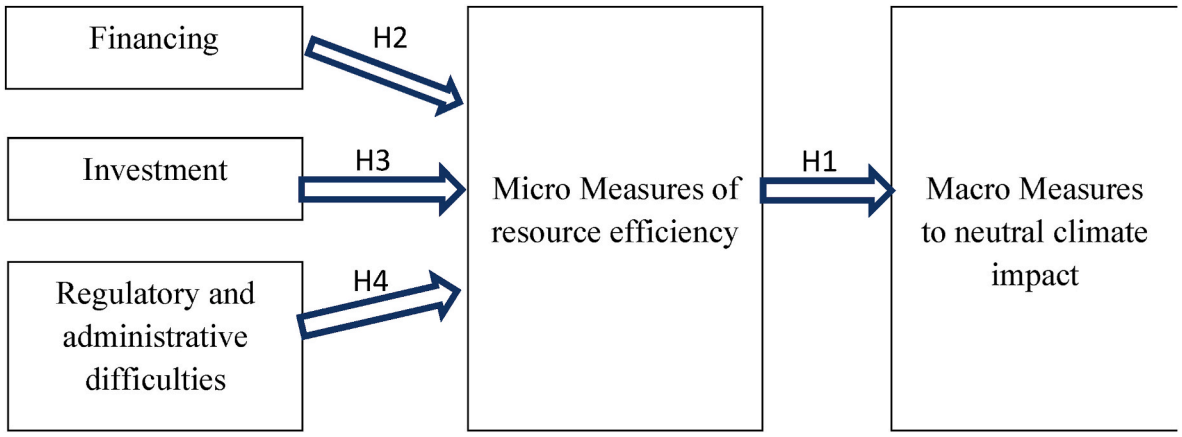

Fig. 1. Research model.

funding source, and legal requirements influence their adoption.

For this purpose, this study used the Flash Eurobarometer 498 – SMEs, Resource Efficiency and Green Markets database, wave 5 provided by the Gesis - Leibniz Institute for Social Sciences database and published in 2022. Data were collected by telephone and computer-assisted interviewing between November 08, 2021, and December 10, 2021. The companies interviewed cover all 27 European Union member states and Albania, Iceland, Moldova, Montenegro, Norway, Serbia, Turkey, the United Kingdom and the USA. The present study focused only on European SMEs (we do not consider USA data). Thus, the database contains responses from 17,144 companies from various sectors (mining and quarrying; manufacturing; electricity, gas, steam, and air conditioning supply; water supply; sewerage, waste management and remediation activities; construction; wholesale and retail trade, repair of motor vehicles and motorcycles; transportation and storage; accommodation and food service activities; information and communication; financial and insurance activities; real estate activities; professional, scientific and technical activities).

The sample is very balanced in terms of geographical dispersion. The oldest company was registered in 1750, and the newest was in 2021. The companies are mainly active in the sectors of construction (28.1%), mobility – transport – automotive (14.6%), and retail (25. 5%). Most SMEs (75.7%) employed up to 50 workers, 17.8% between 50 and 249 workers, and 6.5% more than 50 workers. About a fifth of the companies interviewed (21.5%) had a turnover between 25 and 250 thousand euro; 9.2% between 250 and 500 thousand euro; 26.6% between 500 thousand euro and 10 million euro; 16.5% between 10 and 50 million euro and 10.8% more than 50 million euro (16.7% of companies did not respond). A third of the companies (33.8%) provide only services, while 31.5% sell only products and 34.7% sell products and provide services simultaneously.

3.2. Variables and indicators

This study uses five variables to measure the barriers to implementing resource-efficiency measures (measured through three variables), the micro measures adopted (measured through one variable), and the macro measures of carbon neutrality adopted (measured through one variable). Table A1, in the appendix, describes the variables and indicators included in the research model.

Three variables were used to measure the constraints for adopting resource-efficiency actions: Financing, Investment, and Regulatory and administrative requirements. The "Financing" variable was collected by the fifth question of the Flash Eurobarometer 498: "Which type of support does your company rely on in its efforts to be more resource efficient?". The variable is measured by four items ranging from internal financing (F1) and external financial options (F2-F4). The companies could choose multiple options, and the answer was binary: 1 – 'Yes'; 0 – 'No'. The variable "Investment" was collected by the fourth question of the European survey: "Over the past two years, what percentage of your turnover have you invested, on average, per year to be more resource efficient??". Companies should select one of the five options given. The seventh Eurobarometer question collected the variable "Regulatory and administrative difficulties": "Did your company encounter any of the following difficulties when setting up resource efficiency actions?". Response options comprise nine items, and companies can choose multiple options. The answer was binary: 1 – 'Yes'; 0 – 'No'.

The fourth variable included "Micro Measures" actions and was collected by question Q1 of the survey: "What actions is your company undertaking to be more resource efficient?". The response options also comprise nine items, and companies can choose multiple options through binary responses: 1 – 'Yes'; 0 – 'No').

The fifth variable comprises the "Macro Measures" of neutral carbonization. Data were collected from the fifth question of the Eurobarometer: "What actions is your company undertaking to become climate neutral?". Companies had four response options and could choose more than one in a binary sequence: 1 – 'Yes'; 0 – 'No').

The variables "Regulatory and administrative constraints" "micro measures" and "macro measures" were measured through a score (sum of all items that measure the constructs) since companies could choose multiple options. The score obtained varies between 1 and 9 for the first two variables and 1–4 for the "macro measures". The "Financing" variable was not performed in a score despite the possibility of choosing more than one option because the scale was different.

3.3. Data analysis

The descriptive statistics of the variables were obtained using SPSS (v. 25). Afterwards, a factor analysis was carried out, and an exploratory factor analysis (EFA) was performed with varimax-rotated factor matrices to divide the indicators of latent variables by factors. The statistical objective of EFA is to identify a set of latent constructs from many individual variables (items), resulting in reliable and valid measurement scales. This method starts from a large number of observed variables that are assumed to be related to a smaller number of "unobserved" factors, and it is expected through the implementation of this method to reduce the large number of variables to a much smaller set of factors. A confirmatory factor analysis (CFA) was implemented to confirm the reflective nature of the model. CFA analysis allows evaluating multi-item constructs, these constructs being based on common variance and referred to as factors. A significant relationship between individual variables and how they relate to theoretical concepts is already known when implementing a CFA. In this way, we test the hypothesis that there is a proposed theoretical relationship between the observed variables

and their underlying latent constructs. The objective is to confirm the measurement properties of a set of variables (items) to measure a specified and operationally defined latent construct. The relationships in the research model were tested by applying the Partial Least Squares (PLS) method in the Smart PLS 3.0 software (Ringle et al., 2020). This method fits the purpose of the study because the variables were measured by multiple indicators collected through a questionnaire and did not have a normal distribution (confirmed by kurtosis and skewness statistics). Since the PLS method combines factorial analysis with regression estimation, it allows testing the relationships established in the research model (Ringle et al., 2020). The PLS method is the most appropriate as the objective is to predict the relationships between the main target constructs. The measurement validity and reliability of the items comprising the constructs were also evaluated. This reliability and validity were assessed through (Hair et al., 2019): (i) Cronbach's Alpha measurements (Cα> 0.70); (ii) composite reliability (CR > 0.70); (iii) Average Variance Extracted (AVE >0.50) and (iv) discriminant validity tested by the Fornell-Larcker criterion. Finally, a bootstrap analysis was performed to assess the relationships between the variables of the research model.

4. Results

4.1. Descriptive analysis

Table 1 shows the results of SMEs' perception concerning the constraints to adopting resource-efficient practices.

The results indicate that SMEs rely essentially on their money to finance implementing resource efficiency actions (69.50%). Regarding external financial support, companies mainly relied on public funding such as subsidies, guarantees, or loans (41.20%). We also note that 41.70% of the companies invested, on average per year, less than 1% of their turnover to become more resource efficient, and 30.5% reinvested between 1% and 5%. The biggest obstacles denounced by entrepreneurs to the implementation of more efficient practices were administrative complexity (32.8%), costs of the environmental actions (28.30%), and the lack of supply of necessary materials and parts, products, or services (26.3%).

Table 2 summarizes the micro and macro measures the European SME participants implemented. The results show that regarding micro measures of resource efficiency, the European SMEs sought to minimize waste (62.7% of SMEs), closely followed by energy (60.9%) and materials (55.9%). Few companies use renewable energies (21.1%) and the design of circular products (27.30%). Regarding macro measures taken to neutralise their climate impact, most companies seek to reduce overall carbon emissions (60.70%) and adopt/buy new technological solutions to mitigate them (56%).

Table 1
Frequency of SMEs by type of constraints.

Variables	Items	Frequency (%)
Financing	F1. Its own financial resources	69.5
	F2. Public funding such as grants, guarantees or loans	41.2
	F3. Private funding from a bank, an investment company or venture capital fund	27.7
	F4. Private funding from friends and relatives	6.3
Investment	I1 - Percentage of annual turnover that the company invested on average per year to be more resource efficient	
	<1% of annual turnover	41.7
	1%–5% of annual turnover	30.5
	6%–10% of annual turnover	9.4
	11%–30% of annual turnover	3.7
	>30% of annual turnover	1.7
	Don'tKnow	13.0
Regulatory and administrative difficulties	O1. Complexity of administrative or legal procedures	32.8
	O2. Difficulty to adapt environmental legislation to your company	20.6
	O3. Technical requirements of the legislation not being up to date	19.2
	O4. Difficulty in choosing the right resource efficiency actions for your company	20.8
	O5. Cost of environmental actions	28.3
	O6. Lack of specific environmental expertise	21.9
	O7. Lack of supply of required materials, parts, products or services	26.3
	O8. Lack of demand for resource efficient products or services	19.3
	O9. Complexity associated with environmental labeling and certification	19.

Note: Obs. = 17144 SMEs.

4.2. Measures of reliability and validity

Testing the reliability and validity of the model was preceded by an exploratory and confirmatory factor analysis of the items comprising the five variables of this study. The initial twenty-seven items were reduced to eight due to using scores in the investment, regulatory and administrative difficulties, and micro and macro measures constructs. These eight items were divided into five factors. Factor 1 represents the SMEs finance variable (comprising four items). Factors 2 to 5 incorporate one item and define the investment, regulatory and administrative constraints, and micro and macro measures, respectively. The five factors have a cumulative variance of 71.51%, and no single factor explains more than 50% of the variance. Table A2, in the appendix, describes the results of this exploratory factor analysis. The Confirmatory Factor Analysis specifies the reflective nature of the research model since all items have high confirmatory factor loads (>0.70), and no items had to be excluded (Table 3).

Table 3 contains the measures to assess the reliability and validity of the constructs. The model presents reliability and convergence (Cα>

Table 2
Frequency of sample SMEs in implementing resource efficiency measures at the micro level and climate neutrality at the macro level.

Variables	Items	Frequency (%)
Micro Measures	Micro 1. Saving water	43.6
	Micro 2. Saving energy	60.9
	Micro 3. Using predominantly renewable energy (e.g. including own production through solar panels, etc.)	21.1
	Micro 4. Saving materials	55.9
	Micro 5. Switching to greener suppliers of materials	35.1
	Micro 6. Minimising waste	62.7
	Micro 7. Selling your residues and waste to another company	33.2
	Micro 8. Recycling. by reusing material or waste within the company	45.9
	Micro 9. Designing products that are easier to maintain, repair or reuse	27.3
Macro Measures	Macro 1. Generally reducing carbon emissions of your company	60.7
	Macro 2. Adopting/purchasing new technological solutions to reduce emissions	56.0
	Macro 3. Developing new technological solutions to reduce emissions	39.2
	Macro 4. Offsetting carbon emissions by purchasing carbon credits or funding an equivalent carbon saving elsewhere	15.8

Note: Obs. = 17144 SMEs.

Table 3
CFA; Reliability of the variables (Cα,CR); AVE and AVE Square Root (in bold).

	Confirmatory factor loads	Cα	CR	AVE	Financing	Investiment	RAD	Micro Measures	Macro Measures
Financing		0.858	0.887	0.664	**0.815**				
F1.	0.783								
F2.	0.854								
F3.	0.855								
F4.	0.855								
Investiment	1.000	1.000	1.000	1.000	−0.337	**1.000**			
RAD	1.000	1.000	1.000	1.000	−0.244	0.257	**1.000**		
Micro Measures	1.000	1.000	1.000	1.000	−0.427	0.337	0.415	**1.000**	
Macro Measures	1.000	1.000	1.000	1.000	−0.150	0.152	0.122	0.286	**1.000**

Note: RAD - Regulatory and administrative difficulties.

0.70, CR > 0.70 and AVE >0.50). Through the Fornell-Larcker criterion, we concluded that it has discriminant validity between the latent variables and how they are measured. Additionally, the results of the: (i) Goodness-of-Fit Index (GFI) is 0.954 (reference value > 0.90), (ii) Comparative Fit Index (CFI) is 0.972) (reference value > 0.90), iii) Incremental Fit Index (IFI) is 0.922 (reference value > 0.90), and iv) Root Mean Square Approximation Error (RMSEA) is 0.075 (reference value < 0.08), are all above the reference values which mean that that model has an excellent fit.

4.3. Bootstrap analysis

Table 4 presents the results of the bootstrap analysis of the research model. The results reveal that implementing resource-efficient actions at the micro level influences (β = 0.286) the adoption of carbon neutralization measures at the macro level, confirming H1. Resorting to external financing negatively affects SMEs adopting resource efficiency practices (β = −0.300), ensuring H2. Higher levels of SMES investment to become more resource efficient, a positive influence (β = 0.158) on implementing these actions, confirming H3. The greater the regulatory and administrative difficulties perceived by companies, the lower (β = −0.311) will be the adoption of resource-efficient practices, confirming H4.

5. Discussion and conclusion

Climate change is a global issue. A Millman report on Extreme Weather Conditions in Europe shows that temperatures in Europe have increased by twice the global average, the highest in any continent, causing severe wildfires, droughts, and heatwaves. According to Eurostat, extreme weather and climate-related events have caused over €145 billion in economic losses in the last decade (2010–2020) in the European Union (Eurostat, 2022). European SMEs have a huge responsibility for these climate-related events and, consequently, this escalation of damages. These facts show that the sustainable development envisaged for 2030 is far from being achieved.

If it is true that SMEs are one of the leading causes of climate change, they are also the principal means for its resolution. The present study explores how committed European SMEs are to SDG12. Therefore, we analysed whether the European SMEs' micro resource efficiency actions predicted their adoption of macro measures to carbon neutralization and how constraints at the level of financing, investment, and regulatory and administrative requirement may compromise their implementation of resource efficiency practices at the micro level. Our general hypothesis of positive associations among all these variables was confirmed.

Table 4
Results of boostrap analysis.

Effects on Endogenous Variable	Path (β)	*t* Value (Bootstrap)	ConfidenceInterval	
			2.5%	97.5%
Financing→Micro Measurements	−0.300	6.399*	−0.310	−0.291
Investment→ Micro Measurements	0.158	2.318*	0.145	0.171
RAD→ Micro Measurements	−0.311	4.699*	0.289	0.313
Micro Measurements→ Macro Measurements	0.286	3.874*	0.271	0.301

Note: p < 0.001; RAD - Regulatory and administrative difficulties.

On one side, we found that SMEs that implement specific resource efficiency activities at the micro level are more available to implement macro measures that contribute to reducing their CO2 emissions and neutralise the impact of their production on climate. Most SMEs adopted new technology solutions to reduce carbon emissions, which was confirmed by other research (Dey et al., 2020) and is in line with practices implemented in countries outside Europe (Fadly, 2020; Fernando and Hor, 2017). Saving water, energy, and materials, using renewable energy, and minimising waste were the leading practices implemented by European SMEs to promote efficient use of resources. Similar results were found elsewhere (Chatzistamoulou and Tyllianakis, 2022a; Garrido-Prada et al., 2021; Cunha et al., 2020). However, not all resource efficiency practices are implemented simultaneously, with SMEs prioritizing them. Resource minimisation is the practice most commonly implemented by SMEs, followed by energy saving, reformulation of product production, and water saving (Katz-Gerro and Sintas, 2018). Adopting micro-efficiency measures can be facilitated and boosted by adopting clean technologies that maximize production while minimising waste (Flachenecker and Rentschle, 2018).On the other side, we found that the need to resort to external capital to implement resource efficiency actions discourages SMEs from implementing them. Other researchers found identical results, such as Demirel and Danisman (2019) and Garrido-Prada et al. (2021), that using external funds from banks and public funds negatively influences SMEs' implementation of resource-efficient measures. This situation results from the fact that the use of external financing implies, in addition to high initial and indirect costs, a higher payback of return on investment made commissions (Rizos et al., 2016) and guarantees and collateral that are often difficult to obtain (Hyz, 2011). However, when SMEs use their funds, even financial support from venture capital, they are encouraged to implement resource-efficient measures (Chatzistamoulou and Tyllianakis, 2022a).

Similar discouragement is triggered by legal and administrative requirements to which companies are subject when adopting resource efficiency actions. The regulatory and administrative requirements imposed on the process of implementing resource-efficient measures have been recognized by other studies as one of the most significant barriers that SMEs face (De Jesus and Mendonça, 2018; García-Quevedo et al., 2020). A very complex and bureaucratic legislative framework for the adoption of environmental solutions, challenging to interpret, with high administrative burdens and the need to hire specific human resources, makes companies feel incapable of implementing it (García--Quevedo et al., 2020; Cainelli et al., 2020; Díaz-García et al., 2020; Mungai and Ndiritu, 2023). Furthermore, this obstacle is not reduced with the implementation of more than one resource efficiency activity. As such, with each measure to be implemented regarding of resource

efficiency, SMEs face a new obstacle in terms of legal and administrative requirements (García-Quevedo et al., 2020).

In this line, we found that higher levels of SMEs' investment in resource-efficient activities favour their implementation, corroborating international findings (Demirel and Danisman, 2019).The majority of these investments made by SMEs are in the transition from linear to circular business models, and in particular, they include the adoption of clean technologies that boost the implementation of resource efficiency measures (Özbuğday et al., 2020). Although higher levels of investment in resource efficiency practices enhance their implementation, SMEs are still very reluctant, needing to be convinced by the return that the investment made can generate in terms of economic performance (e.g., increased sales), cost savings of production by becoming more efficient and greater competitiveness (Jové-Llopis and Segarra-Blasco, 2018; Horbach, 2018).

Overall, the present study reveals that high constraints for SMEs in terms of financing, investment, and regulatory and administrative requirements negatively influence the adoption of resource efficiency measures at the micro level, jeopardising the chances of achieving a climate transition. In this way, SMEs can register more significant impulses to enhance resource efficiency practices when there is the implementation of clean technologies and specialized business monitoring, when they experience greater resource productivity and competitiveness and when they use green energy, thus being a viable reality that Resource efficiency can enable a transition to sustainability (Chatzistamoulou and Tyllianakis, 2022b). This study supports the idea that the business activities of European SMEs can contribute to the sustainable growth and achieve favourable climate change. There is still a long way to go, but entrepreneurs seem aware of their role in sustainable development.

5.1. Theoretical implications

This study contributes to the existing literature in numerous ways. In terms of contribution to the current literature and research, this study offers insight to overcome some gaps around business activities' role in climate change. Although the literature has been quite elaborate on the factors affecting SMEs' engagement in resource-efficient actions, more evidence is needed on what affects their commitment to such practices or its effect on achieving net-zero targets by 2050 as launched by the European Green Deal. Our study uses rigorous statistical analysis, a large sample of European entrepreneurs from 35 countries, and numerous economic activities. Thus, the study provides empirical support for the engagement of SMEs in resource efficiency actions to achieve the twelfth SDG and sustainable transition.

5.2. Practical and managerial implications

In terms of managerial contributions, evidence from this study shows that SME entrepreneurs' engagement in resource efficiency actions within the company translates into global actions for climate preservation. However, there is room for policymakers to intervene to help entrepreneurs pursue a more efficient use of resources. Firstly, once regulatory and administrative difficulties have been perceived by companies for the influence of levels in adopting resource-efficient practices, policymakers should strive to simplify the current administrative and legal procedures that prevent entrepreneurs from being more efficient in terms of resources. One suggestion would be the creation of administrative service stations in which companies could deal with all administrative processes in a single and consolidated way instead of going through several services and different service counters. Second, the results demonstrated that the use of external financing negatively affects the adoption of resource-efficient practices. However, higher levels of investment in these practices by SMEs encourage these companies to become more efficient in managing resources. Climate action is costly. In this way, decision-makers should grant some support by reducing and exempting certain taxes and fees inherent in implementing resource-efficient measures. Climate action is costly. Tax incentives could also motivate entrepreneurs to reinvest more of their profits in resource-efficient practices. In addition, granting government subsidies, increased interest rates on bank financing, grace periods for capital, and interest on external loans could encourage greater investment by companies in resource-efficient practices while reducing and mitigating the existing obstacle in resorting to external financing for SMEs.Finally, political leaders should focus on boosting the use of renewable energy by SME entrepreneurs. Several financial programs (namely at the European Union level) already exist. Still, if the focus is to fight climate change and secure the planet for future generations, more financial funds must be made available so SMEs can have a stake in this transformation.

5.3. Limitations and future research

Finally, concerning limitations, this study has a few limitations that could be addressed in future research. First, this study analyzes data from numerous sectors of activity, which may not produce the same sort of deep insights as a study focusing only on one sector would. Furthermore, the investment, financing, and legal and regulatory requirements inherent to implementing resource efficiency practices differ between activity sectors. A company in a secondary activity sector has more obligations and pressures to implement environmentally sustainable productive solutions than those in the tertiary activity sector. Therefore, we recognize that a study that focuses on a sample of companies from just one activity sector may obtain different results from the study. Second, we use data from entrepreneurs of 35 countries which may bias the results. It has been recognized that although nearly every society recognized the need to achieve a balance between economic growth and environmental sustainability the particular goals and actions to reach this balance vary internationally, between cultures (Ferreira et al., 2021). Finally, the study uses only three independent variables to explain the engagement of SMEs with micro actions to promote resource efficiency which may condition our results. Indeed, other factors such as marketing purposes from market-oriented organizations could also influence the adoption of micro efficiency resource and climate transition. For example, there is evidence that SMEs tend to experience reputational benefits from their responses to climate change (Alam et al., 2022). Moreover, in the current economic context characterized by a process of inflation, particularly in energy sources, rising interest rates and interruptions in supply chains (initiated by Covid-19 and perpetuated by the Russian-Ukrainian conflict), it would be interesting to investigate the impact of these particular circumstances on SMEs entrepreneurs' adherence to more resource efficient measures. It would also be interesting to replicate this study by country and by business sector to see whether there are differences. This would allow the definition of concrete and specific political measures by country and SMEs sector of activity.

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CRediT authorship contribution statement

Sofia Gomes: Conceptualization, Methodology, Software, Writing – original draft, preparation, Visualization, Investigation, Software, Validation, Writing – review & editing. **Micaela Pinho:** Conceptualization, Data curation, Writing – original draft, preparation, Visualization, Investigation, Supervision, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial

interests or personal relationships that could have appeared to influence the work reported in this paper.

The authors declare that this work is original and has not been published elsewhere nor is it currently under consideration for publication elsewhere.

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jclepro.2023.139016.

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