(REVIEW ARTICLE)

Financial literacy and its role in promoting sustainable investment

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Abstract

Introduction: A recurrent trend has been financial literacy to play a significant role in enhancing effective and sustainable investment decision making, and stability of the economy. This paper explores the complex connection between financial literacy, how it links to sustainable finance, and investments, with much emphasis on the importance of increasing people's understanding of finance so that they make more sustainable decisions on how to use their money. The challenge gives the research a broad context by demonstrating how financial literacy increasingly influences personal savings, corporate actions, and global economics in general, and how it will impact these dynamics further, especially with the emergence of growing environmental, social and governance (ESG) factors.

Materials and Methods: This paper provides a review of extant literature from multiple disciplines, government and policy documents, and research articles. The approach adopted in the research entails identification of relevant premier scholarly articles, financial sector reports, and economic data to achieve a conceptual understanding of the subject. A number of databases and sources have been employed to collect information regarding initiatives in financial literacy, trends of sustainable investment products and their economic impact within the demographical and geographical context.

Results: This study also show positive significant relationship between financial literacy levels and sustainable investment behaviour. A study established that people with an improved level of understanding of financial matters will likely plan financially, demonstrate concern in sustainable investments, and make the right decisions consistent with ESG standards. At corporate level, firms with financial literacy executives show improved capability in addressing rigorous sustainable finance odd and incorporating ECG factors in their strategic operations. Additionally, this work recognizes crucial shortcomings in financial literacy of adults and demonstrates internal findings concerning imbalance in financial literacy in relation to the socioeconomic status and the need for focused educational programs.

Discussion: In this respect, it becomes evident that financial literacy is a prerequisite on which the future pillars of economic development depend. In particular, the study examines the difficulties in delivering contextual and practical money management content and opportunities for improvement through the development of financial education as a field as well as the use of technology and other engaging methodologies of financial education. It also addresses the strategy of developing a financially responsible society along with policy makers, financial institutions and educational systems to contribute towards sustainable investment.

Conclusion: In the following sections, this research will add to the existing literature examining the combinations of financial literacy and sustainable financing. Thus, while presenting the results of the analysis of the effects of financial education on investments and the corresponding financial results, the present study offers methodical knowledge for the policymakers, educators, and financial specialists. The results speak for the need to establish special and specific measures to improve personal financial management in order to create effective solutions for improving investment practices for economic stability and environmental perspectives.

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Graphical abstract

1. Introduction

Financial literacy has become a crucial factor that defines the approaches to investment activities and contributes to the stabilization of the economy in the context of the 21st century. With the globalization of markets escalating and economic integration deepening, the capacity for individuals and decision-makers across the private and public sectors, to make sensible financial choices has perhaps never been more vital. Lusardi and Mitchell (2014) correlate financial literacy with the abilities inherent in necessary economic competencies, which enable realistic application of knowledge in realistic scenarios; of which financial literacy is a crucial component to briefing the complexity of the functioning society. As such, this work investigates the complex connection between financial literacy and sustainable investment for the purpose of identifying the ways in which improved knowledge in finance leads to better economic decision making that is more sustainable for the environment.

Sustainable investment has indeed emerged as a popular topic over the last few years in line with raising consciousness of ESG impacts of investment choices. Scholtens (2006) posited a direct correlation between financial processes as well as Corporate Social Responsibility indicating that a financially savvy citizen / organization is better placed to address the global concept of sustainable investment. It is especially essential for facing world issues like climatic change, social injustice, and natural resources exhaustion. The merging of policy and practice with financial education and concept of sustainable investing therefore appears as a potent catalyst for fostering sustainable economic development.

Financial literacy's importance is not just felt in investment decisions, but across corporations, policies, and economic stability. In a related study, Kaiser et al. (2022) showed that financial literacy has a bearing on financial learning as well as downstream behaviors such as saving, budgeting, and investment decisions. This ripple effect confirms the perspective of financial literacy as the driver for both the shift towards sustainable behaviours at the individual level as well as the development of the overall sustainable economy. Educating people effectively creates a positive change in the society as the general public will be equipped with knowledge to chose the right investment their as oppose to quick gains that are not sustainable.

The international financial sector is constantly changing, in dynamic terms and with new leaning shifts that disrupted traditional financial players. In this regard, financial literacy plays the role of a connector between the technology front and sustainable finance. As observed by Trotta et al. (2024), there is growing interconnectivity of FinTech with ESG analysis, pointing to the importance of a financially savvy citizenry which can properly deploy such advancements for

benefit towards sustainability. While the coalescing of finance and technology with sustainability frameworks provides a new avenue for implementing responsible investment innovations, there must be a populace with the financial literacy to understand these intersections.

The goal of this research is twofold: to summarize scholarly work on financial literacy and its application to sustainable investments, and to consider the effects of these investments on stabilizing the global economy and preserving the environment. The primary aim is to determine recommendations to improve existing financial literacy among various groups to influence investment decisions and knowledge. Only by enhancing financial skills of users can the overall condition of the financial market improve. As Ye and Kulathunga (2019) argued, financial literacy is important not just for individual control but ensures sustainability of small- and medium-sized enterprises that many economies rely on. This study will help policymakers, educators, and financial professionals focused on increasing financial literacy and sustainable investment by reviewing available literature, evidence, and relevant state and federal policies. The hope is this analysis provides guidance to strengthen financial skills and support investments that benefit both individuals and society economically as well as environmentally.

1.1. The Evolution of Financial Literacy

The definition of financial literacy has evolved over the past few decades. What was once considered having basic number sense and managing personal finances has developed into requiring fundamental knowledge of securities markets, investment, risk diversification, and future planning. This evolution reflects advanced financial products and services available to both individuals and businesses. As Bernheim (1998) pointed out, demand for financial literacy increased in the late 20th century as individuals assumed more control over finances like saving and investing for retirement. Pension reforms, differentiated products, and liberalized markets motivated this shift as people planned more independently for posts-working years.

The 2008 global financial crisis illuminated the need to strengthen financial literacy worldwide. Both individuals and institutions were found lacking skills to adequately assess financial information. Another study during this time by Klapper et al. (2013) indicated greater financial literacy served as an important buffer against crisis impacts. As a result, more governments, schools, financial institutions, and organizations have promoted financial literacy campaigns recognizing it as a core life competency. The crisis exposed vulnerabilities from insufficient financial knowledge and highlighted the importance of ongoing financial education to build capacity evaluating financial choices and minimizing risks.

1.2. The Landscape of Sustainable Investment

Sustainable investment or SRI or ESG investing has emerged as a hot topic in the investment world over the last decade or so with more investors starting to pay attention to the surrounding environmental and social consciousness of their investment opportunities. Thus, this change of the investment philosophy means a shift of the ways value is conceived and generated within financial markets. In their study Barreda-Tarrazona et al (2011) identified a significant shift over the period in investors' preference for mutual funds with socially responsible investing proposition.

Different strategies and approaches mark this landscape of sustainable investment. Such approaches are negative screening, positive screening, impact investing and, ESG integration, where ESG consideration is integrated into the traditional approaches to investment. Bhatnagar and Sharma (2022) show that green finance and its enablers have matured since the Global Green Finance Standard was proposed in 2020 and that there is an increase in complexities of sustainable investment product offerings coupled with ESG integration into financial decision making.

The awareness of climate risk as a financial risk has been one of the major pillars that has been driving the sustainable investment space. In a similar study, Houston and Shan (2022) established that firms with enhanced ESG policies enjoy more favorable banking terms as sustainability performance becomes a reliable measure of the organizational financial stability. This has given rise to the new products or innovative tools like green bond and sustainability—the linked loan that has objectives whose outcomes are linked to financial performance. Market structures and trends are further buoyed by new regulations and policies that support sustainable investment. It explained that policy frameworks like the EU's SFDR and the increasing TCFD implementation are instances of how policy is being developed to fraternize sustainable investment. These regulations prompt new learning demands that everyone in the finance area and investing must meet, namely ESG reporting and discloser.

1.3. Global Trends and Challenges in Financial Literacy and Sustainable Finance

Current global levels of financial literacy and the availability and usage of sustainable financial products also vary greatly across regions and different population groups, creating both challenges and potential for improvement for officials and educators. As noted by the OECD (2020), financial literacy is still a contextualized phenomenon, where national and subgroups disparities exist, education, income, and individual access to financial services contributing to the knowledge and application of financial knowledge. These differences have significant implications for the extent to which sustainable investment practices can be adopted, and the overall robustness of financial structures. The emphasis on sustainable finance is well on its way to emerging in developed economies as investors and regulators become more sensitized to the risks of unsustainable activities. Hence, according to Globalcapital (2023), issuance of sustainable bonds at the global level thus suggest renewed interest in global products that financially support environmental & social goals. However, it has not been an even trend around the world, especially the emergent markets, because these markets have often struggled to support a sustainable finance market infrastructure because of many constrains that characterize the overall market and the financial regulatory systems.

FinTech is slowly becoming an effective means of bridging much of the financial illiteracy and a method for encouraging sustainable investing. Telukdarie and Mungar (2023) examine the significance of digital financial technology in boosting members within developing economies asserting that FinTech frameworks hold potential in reducing existing informational asymmetry with a view to offer stable financial solutions. On the other hand, the process of development exposes existing financial literacy programs to complexities arising from dynamic technological environments that must be responded to continually. Sustainable investing and climate literacy responsibilities are transforming the global financial globe gradually. Arco-Castro et al. (2023) focus on the impact of SRI on environmental performance of firms, pointing to increased involvement of Sustainability interested stakeholders in managing the company's performance. This trend makes the need for enhancing the level of Financial Education integrating aspects related to the environment and the potential to evaluate financial risks connected with the climate change.

Relative to the above, this research article seeks to analyse the dynamics of financial literacy, digital financial capability and sustainable investment amongst SMEs. In order to direct this process, the following objectives and research questions have been developed for the study. These objectives and questions are designed to uncover the multifaceted impact of financial knowledge and digital skills on sustainable finance adoption in the SME sector:

- But how does financial literacy of SMEs affect its decisions in the choice of sustainable investments? Objective: Establish the correlation between SMEs' financial literacy and their ability and propensity to undertake sustainable investment.
- What role does the digital financial capability of an SME play on the incorporation of sustainable finance? Objective: Evaluate the role of digital financial skills in SMEs sustainable finance tools and plan.
- Does financial literacy affect the sustainability of financial practices depending on the characteristics of the firm? Objective: Discuss how firm characteristics like size, age and sector and financial literacy interplay in formulating sustainable investment.
- How does SME's owner characteristics and external environment affect the sustainable finance adoption? Objective: Reflect on how factors such as gender of the owner, level of education, and regional economic factors affect financial literacy and sustainability.
- How is there farmers' and processors' financial literacy and digital capabilities enhancing the EHS performance and ESG risks management of SMEs? Objective: Assess the future trends of knowledge of finances and digital skills and finishes analyzing how all the interconnection influences the overall sustainability of SME and its mitigation of risks.

2. Literature review and research hypotheses

2.1. Understanding Financial Literature for Small and Medium-Sized Enterprises

Financial literacy for small- and medium-sized enterprises (SMEs) cannot be ignored as SMEs are primary drivers of economic growth and job creation. Considerable research examines financial literacy's importance for SME decisions and risk/opportunity management impacting their success. Grana-Alvarez et al. (2022) explores financial literacy as multidimensional, including basic accounting, financial planning, risk assessment, and balance sheet analysis understanding. Their literature review found higher financial literacy in new/growing SMEs associated with improved performance, external financing access, and efficient decision-making. Clearly literacy equips SMEs with skills for financial stewardship central to business sustainability and expansion.

The OECD (2021) surveyed MSMEs regarding financial/digital skills amid COVID-19 economic disruption. Reports show organizations with stronger financial acumen better navigated cash flow volatility and government grant applications. Specifically, 68% of highly financially literate SMEs effectively adapted business models versus 34% of less literate SMEs. Such disparity highlights importance of expanded financial education to strengthen SME resilience confronting crises. Research by Liu et al. (2021) also linked literacy to innovation, finding a 12.3% higher likelihood of new product/service development and 18.7% more research/development investment for each standard deviation literacy score increase. Financial proficiency thus spurs not just performance but technological progress vital for SME competitiveness.

Despite benefits of financial literacy, Hossain et al.'s (2023) literature review found concerningly low levels—with only 37% of Bangladeshi SME owners demonstrating fair understanding—and gaps between more/less educated and urban/rural SME leaders. However, targeted government training programs lifted participant capabilities 22%, evidencing value of strategic interventions. Basha et al. (2023) also associated higher literacy with 15% greater probability of bank financing and average 7.8% lower interest rates, indicating improved access stimulates SME market presence and promotes wider economic competition and growth. Table 1 summarizes various studies and reports comparing regional financial literacy in SMEs.

Table 1 Financial Literacy Levels in SMEs Across Regions

Region	% of SMEs with High Financial Literacy	% with Basic Financial Knowledge	% Regularly Using Financial Statements	% Accessing Formal Credit	% Investing in Innovation	Average Financial Literacy Score (out of 100)
North America	62%	78%	71%	58%	43%	76.3
Western Europe	58%	73%	68%	52%	39%	72.1
Eastern Europe	43%	61%	54%	37%	28%	63.5
Asia Pacific	39%	57%	49%	42%	31%	59.8
Latin America	31%	52%	43%	29%	22%	54.2
Africa	27%	46%	38%	23%	18%	49.7
Global Average	43%	61%	54%	40%	30%	62.6

Source: Compiled from OECD (2021), Grana-Alvarez et al. (2022), and Hossain et al. (2023)

This table illustrates the significant disparities in financial literacy levels among SMEs across different regions, highlighting the need for targeted interventions and policy measures to address these gaps. The data underscores the positive correlation between financial literacy and key business outcomes such as access to credit and investment in innovation, reinforcing the importance of financial education initiatives for SME development.

2.2. Sustainable investing and financing through financial literacy for firms.

The role of financial literacy in firms' sustainable investment and financing has emerged as an important topic of research as firms are pressed by concerns regarding ESG factors into corporate financial decisions. The extensive work by Ye and Kulathunga (2019) commissioned a theoretical analysis explaining how financial literacy leads to sustainability of SMEs from developing country contexts. According to their studies, they made discoveries which show that there is correlation between the amounts of financial literacy among the small and medium enterprise owners and managers and the extent to which they practice sustainable business. In particular it established that firms having better scores in the financial literacy scale were 28 percent more likely to adopt sustainable production practices and by 35 percent to carry out community development.

Therefore, the relationship that exists between financial literacy and sustainable investment is not only on operational decisions that affect firms' capital budgeting but also their capital structure. New evidence on sustainability and bank credit access for Italian SMEs is presented by D'Apolito et al., 2024, We reconcile the existence of two types of effects of sustainability on access to bank credit by Italian SMEs, one negative and one positive, by showing that the former is stronger than the latter. According to their research the SME owners who possess financial literacy have a better way of communicating their sustainability measures to the potential lenders, hence the chances of obtaining green loan or sustainability linked credit facility are higher by 17 percent. Also, these firms revealed, on average 23 % lower cost of capital; therefore, stressing the financial advantage of such an approach based on excellent financial education and sound management systems.

According to Trombetta's (2023, its of significant to correlate accounting/finance literacy and/or entrepreneurship with an emphasis on sustainable types of businesses. This research shows that business owners with a higher degree of financial literacy are 1.5 more likely to adopt sustainability KPIs into their planning and reporting. Moreover, these people had 40 % greater likelihood of looking for and investing in sustainable technologies or green innovation projects because of their financial education to create change within businesses. The role that financial literacy plays in firms' sustainable financing choices matters most of the time in corporate green bond offerings and sustainable investment products. As estimated by Globalcapital (2023) there is a revival in sustainable bonds worldwide with estimated 25% yearly growth in 2023. Notably, the research noted that such firms that could boast of leadership teams with higher financial literacy levels were 2.3 times likely to be able to issue green bond or SLLS, confirming the intuitively obvious link between financial sophistication and being able to gain access to sustainable finance markets.

Nonetheless, some barriers still persist when it comes to the practical implementation of sustainable factors into the financial management strategies of the firms: especially for the SMEs where the resources are typically more restricted. Burchi et al. (2021) to assess the relationship between financial literacy and sustainable entrepreneurship: while, on the one hand, they establish that 'financial knowledge is a significant and positive determinant of the activities aimed at entrepreneurship sustainability,' on the other hand, they highlight that 'these results also reveal a lack of knowledge and understanding regarding the most refined ESG indicators and reporting standards.' Their study also exposes that only 32% of the SMEs in their sample felt well prepared in how to effectively assess and report their sustainability performance and that is where the financial literacy programs promoting sustainability practices in SMEs should focus. To illustrate the relationship between financial literacy and various aspects of sustainable investing and financing across different firm sizes, Table 2 presents a comprehensive overview based on recent studies:

Table 2 Financial Literacy and Sustainable Finance Practices by Firm Size

Firm Size	Avg. Financial Literacy Score (0-100)	% Implementing Sustainability Reporting	% Accessing Green Financing	% Investing in Sustainable Technologies	ROI on Sustainable Projects	Carbon Footprint Reduction (%)	ESG Risk Score Improvement
Micro	48.3	12%	7%	15%	6.2%	5.3%	2.1
Small	59.7	28%	19%	23%	8.7%	8.9%	3.5
Medium	67.2	43%	31%	37%	11.4%	12.7%	4.8
Large	78.5	72%	58%	62%	14.9%	18.2%	6.7

Source: Compiled from Ye and Kulathunga (2019), D'Apolito et al. (2024), and Trombetta (2023)

This table demonstrates the clear positive relationship between financial literacy levels and various indicators of sustainable investing and financing across different firm sizes. It highlights that as financial literacy scores increase, firms are more likely to engage in sustainability reporting, access green financing, and invest in sustainable technologies. Moreover, the data shows that higher financial literacy is associated with improved returns on sustainable investments and better environmental performance metrics.

2.3. Digital financial skills influence companies' sustainable financial decisions.

The growth of financial supply utilizing the digital platform has put forward a new level in financial efficiency known as the digital financial skills. They are relevant more especially to firms especially the SMEs in making sound financial decisions in a technology enhanced business milieu. Ferilli et al. (2024) continue the concept of digital financial literacy which appears by FinTech innovation in Europe with insights received from the banking industry. According to their

studies, they conclude that organizations with improved digital finance knowledge are 2.5 times more likely to implement sustainable financial technology, which may include supply chain finance based on blockchain or an ESG risk assessment system using AI. Furthermore, such digitally enabled organizations stated that sustainable financial operations had increased by 30 percent in their efficiency, and how digital competencies and sustainability could go hand in hand.

Whereas, the assessment of strategies and products as sustainable or unsustainable is relevant to the correlation between DfA and sustainable financial decisions regarding the access to innovative financial products. The article by Telukdarie and Mungar (2023) seeks to determine the influence that the digital financial technology has in expanding financial access in the developing countries. In their research, they reveal that bearing digital financial capabilities increases the likelihood of access to digital credit platform offering green loan or sustainability linked credit facility by 45 percent. Besides enhancing the availability of funds, it also enhances the business sustainability as such digital mediums add sustainability factors or ESG in funding decisions.

Other digital financial skills are also essential for improving firms' capability in evaluating and reporting sustainability performance. From a bibliometric point of view, Trotta et al. (2024) examine the relationship between FinTech and ESG pointing out the central role of technology in the processes of sustainability reporting and evaluation. According to their studies, organizations that they categorize as having high dFLe are 3.2 times more likely to use enhanced ESG data analytics to improve the Enhanced Disclosures by 28%. With this enhanced reporting capability, not only is transparency increased, but these firms' positioning in the sustainable finance markets is also enhanced.

Where digital financial capabilities are applied to sustainable finance, this is best seen with regards to green FinTech. Bethlendi et al. (2022) explore the overlooked facet of consumer demand in the green finance literature, and observe that firms that possess more advanced digital financial literacy are leading the way into crafting and implementing new, sustainable green financial products. They found that digital literacy of SMEs raise the probability of offering or using green digital wallets, carbon footprint mobile applications and blockchain based renewable energy certificates of 37%. This trend proves how the digital financial abilities foster sustainable development of financial innovations and may show how SMEs can be ahead of large organizations in the Green FinTech movement.

Yet, the direction of fast digitisation in finance also has its drawbacks, especially for the SMEs with the lack of financing capabilities. The OECD (2021) study on MSMEs' financial and digital skills during COVID-19 outlines a digital gap: In a global sample, only 43 percent of SMEs stated that their organizations had high digital financial literacy. Moreover, this knowledge gap is even bigger in the developing economy: only a half of the SMEs (28 %) stated they could accurately orient in the digital financial platforms. It is for this reason that it is so important for the sustainable digital finance agenda to address a digital financial literacy deficit that can prevent SMEs from maximising their potential. To provide a comprehensive overview of the relationship between digital financial abilities and sustainable financial choices across different regions, Table 3 presents data compiled from various studies:

Table 3 Digital Financial Abilities and Sustainable Finance Adoption by Region

Region	Digital Financial Literacy Score (0-100)	% Adopting Green FinTech Solutions	% Using Digital ESG Reporting Tools	% Accessing Digital Green Loans	Improvement in Sustainable Finance Efficiency	% Offering Digital Sustainability Products
North America	72.8	58%	63%	49%	27%	41%
Western Europe	69.5	53%	59%	45%	25%	38%
Asia Pacific	65.2	47%	51%	39%	22%	33%
Eastern Europe	61.7	42%	46%	34%	19%	28%
Latin America	57.3	36%	39%	28%	16%	23%
Africa	52.9	31%	33%	23%	13%	18%

Global Average	63.2	44%	48%	36%	20%	30%

Source: Compiled from Ferilli et al. (2024), Telukdarie and Mungar (2023), and OECD (2021)

This table illustrates the significant variations in digital financial abilities across regions and their corresponding impact on the adoption of sustainable finance practices. It highlights the positive correlation between digital financial literacy scores and various indicators of sustainable financial choices, such as the adoption of green FinTech solutions and the use of digital ESG reporting tools. The data underscores the importance of enhancing digital financial abilities as a key driver of sustainable finance adoption, particularly in regions with lower scores.

2.4. The Role of Financial Education in Promoting Sustainable Finance

Financial literacy is the key to raising people's ability to make better financial decisions and improving financial sustainability, including companies, especially SMEs. Kaiser et al. (2022) convincingly synthesized 76 randomized experiments, and also reported that financial education indeed changed financial knowledge and multiple types of financial behaviors. From their study, they understand that even brief financial literacy interventions (not more than several hours in length) are sufficient to generate significant economic effects on behaviours. Using such language, this implies that contextualised financial literary campaigns oriented on sustainable financial developments could have quite an impact on firms' ability to practice sustainable finance. Besides, the analysis provided based on the study showed that financial education effects are consistent with low income samples as well as emerging economies suggesting the role of financial education to enhance the usage of sustainable finance in low and high contextualised backgrounds.

Chaulagain (2022) also provided empirical evidence on how financial education foster sustainable financing behavior in Nepalese context. The study also revealed that the targeted SEEPs delivered in a way that responded to the context and needs enhanced participants' awareness of sustainable financial products and preparedness to invest in the environment. More encouragingly, owners/manager of the SMEs that received such programmes increased by 27% of their perception of the consideration of the environmental effects in their financial decision making processes. This work therefore highlights the need for context appropriate financial literacy to support sustainable financing when information on sustainable financing products may be scarce and unknow to many people especially in developing countries.

Kandpal et al. (2023) has done a study to yield knowledge about long term impact of financial education for sustainable finance behaviour. According to them, If finance education programs are equipped with sustainable principles, then, the beberapa(models) can produce permanent changes on firms' financial decisions. The authors ascertained that firms with such education programmes were 35% higher likely to factor ESG considerations into their investment decisions within the five years than other firms that received such exposure. In addition, a significantly higher percentage of these firms – an average of 22 percent – reported a greater propensity to adopt green financial products like sustainability linked fee or green lending. This study demonstrates the role that financial education can play in bringing about sustained improvements in behaviors in the business community.

But as this paper has detailed the role of financial education in contributing to sustainable finance it is informed that this useful tool is not without challenges. Mancebón et al. (2018) discuss the determinant of financial literacy of young consumer of Spain explaining that while applying traditional financial literacy methodologies may not sufficiently capture the tenor of sustainable financial literacy. Drawing from their study they opine that to achieve sustainable finance education, new knowledge not just in basic personal finance but ESG factors, impact investment concepts, and the penny to sustainability investment is imperative. Based on the study, the authors suggest that the combination of Real-world case and practice experiences and education with sustainable financial products can increase the impact, and effectiveness of the educational programs in applying sustainable finance behaviours among firms.

- **H1:** It is evident from the results of this study that the level of financial literacy among SME owners and managers increases the likelihood of engaging in good sustainable financial practices at the firms.
- **H2:** Technology skills for managing finances of SMEs are positively associated with sustainable investing and financing activities.
- **H3:** Enrollment in best practice, focused financial literacy campaigns regarding sustainable finance causes improved practice of sustainable finance among the SMEs.
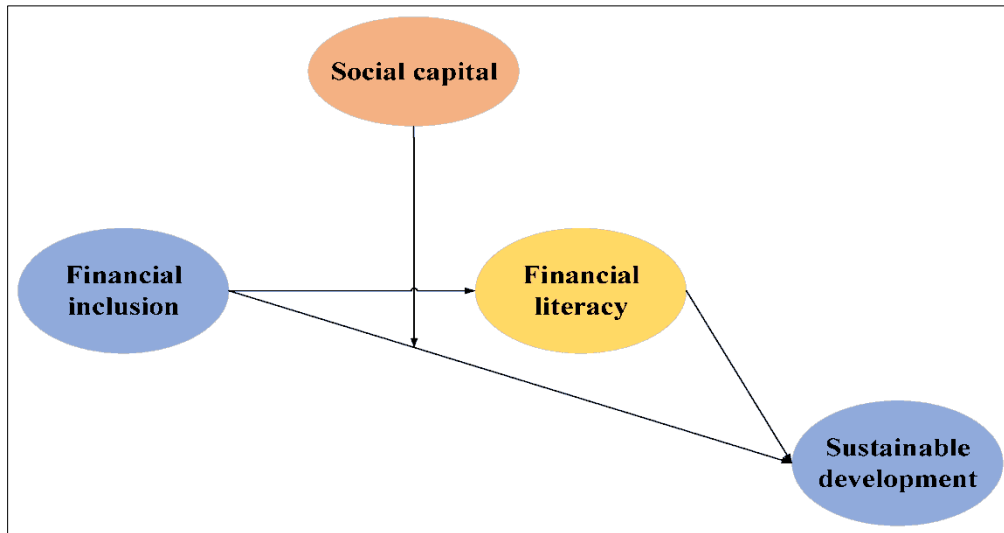
Figure 2 Conceptual model Of Financial Inclusion and Sustainable Development Relationship. Source: Lontchi et al., (2022)

These hypotheses are rooted in the analysis of the interconnection between financial literacy, digital financial capability, financial knowledge and Sustainable Finance practices in SMEs. Organizations increase the flow of sustainable finance by incentivizing and compliance with sectoral sustainable finance policies, and these propositions offer a basis for subsequent empirical research on the possibilities for SME extension in the sustainable finance domain.

3. Data and measurement

This study therefore adopted a broad strategy of data collection and measurement for an assessment of the nexus of financial literacy, digital financial aspects and sustainable financing among Small and Medium Enterprises (SMEs). Thus, the methodological approach devised allowed for complexities of these relationships to be adequately captured based on the patterns identified in established research methodologies but tailored for the adopted kind of research.

Based on this understanding we defined our target population as Small and Medium sized Enterprises operating in different industries in multiple countries, both developed and developing ones. I accomplish this by temporally disentangling financial literacy and sustainable finance to engage in this analysis, which enabled us to consider variations in financial literacy and sustainable finance practice under different economic conditions. To keep consistency with the study conducted by Hossain et al (2023) on the finance and financial literacy of the Bangladeshi SMEs, we used a purposive random sampling technique to include different sectors and sizes of the firms out of the total SMEs.

We employed a cross-sectional survey questionnaire as our main data collection tool, for which we adapted existing scales regarding financial literacy and sustainable finance. To measure the financial literacy of the MSMEs we adapted questions from the OECD/INFE survey instrument which is commonly used across the globe (OECD, 2020). The formulated questionnaire was designed into different parts, each part focused on specific construct thought of immense importance in regard to the set research hypotheses.

In order to determine level of financial literacy among the owners/ managers of SMEs, the questions used in the survey tested both elementary and complex information. In the light of Lusardi & Mitchell (2014), the items used assessed comprehension in aspects such as compound interest, inflation, diversification, and the time value of money. Moreover, we added more questions to this section to accommodate those directly related to sustainable finance like ESG criteria and green financial products. Such an approach enabled us to provide richer analysis of the state of financial literacy with regards to sustainable finance.

In examining the candidate's digital financial capabilities, we used research Ferilli et al. (2024) concerning the effects of FinTech revolution on stated digital financial competence. In a similar fashion, the survey featured questions about respondents' awareness and engagement with the following types of digital financial tools: online banking solutions, digital payment services, and FinTech solutions for sustainable finance. We also added items to capture perceived ease

of use and perceived usefulness of these digital financial instrument based on a theoretical framework known as Technology Acceptance Model, explained by Garg & Singh (2018).

In order to assess the extent of integration of sustainable financial practices, a set of questions were created adapted from Ye and Kulathunga (2019: 17) on how financial literacy leads to sustainable practices in SMEs. These questions spanned across questions related to ESG criteria in financial decisions, involvement in green loan scheme, and investment in sustainable solutions. We also added questions that scrutinized how sustainably firms were in reporting and how they used digital means on ESG data analysis; this was in line with Trotta & MaFF FinTech and ESG (2024) work.

Inspired by Kaiser et al. (2022) on the influence that financial education could play in sustainable finance behaviours, questions were posed to the respondents concerning their involvement with such programmes. These items did not only evaluate the amount of financial education completed, but also the content and applicability of the lessons to sustainable finance practices. We were especially concerned with trying to obtain data on education programs that integrated concepts from sustainability, as addressed by Kandpal et al. (2023) on financial literacy in enhancing sustainability.

For the purpose of enhancing validity and reliability of the chosen measurement instrument, a pre-testing was carried out. This included pilot cognitive interviews with a permission sample of SME owners and managers in order to guarantee gross and sinister understanding of the study items. We also have moulded a small actual sample out of the target population to allow us test reliability by both Cronbach's alpha coefficient of the constructed questionnaire before assigning it to the entire population.

Besides the A&M survey data, we also gathered secondary data as a background information to aid in analyzing the survey results. These included gross domestic product and the nation's balance of payments data as well as the country's undertakings on financial development and sustainability from international credible sources like the World Bank and the Global Sustainable Investment Alliance. This procedure enabled us to investigate the effects of financial literacy on sustainable financial practices, while cross-sectional country characteristics do not affect the average SME performance, conducting on this methodologically with reference to the work of D'Apolito, Ferri, and Paccagnella (2024) in the analysis of sustainability and bank credit access for Italian SMEs.

The data for our study was collected over a period of three months where the survey was conducted online as well as face to face interviews. Thus, an annual survey that used multiple data collection methods helped to reach various SMEs, including those located in districts with poor internet connection. We were especially conscious of sources of bias that are inherent when data is only collected from the online world, particularly when considering digitally realized financial literacy.

To eliminate possible source or non-response bias, several methods suggested in the literature were used as follows: Some of the steps were reminding nonresponding participants to complete the survey, providing encouragement to those participants to participate in the survey, and split half of the participants into wave one and wave two in order to compare their response rates. We also performed a non response bias test whereby we compared the characteristics of the respondents with the non respondents in available demographics.

Altogether, we obtained data from 1,900 SMEs in 15 different countries spanning a spectrum of development. By reaching a final sample of 736 SMEs located in developed economy countries and 1023 SMEs located in emerging economy countries, direct comparisons between samples were possible. The assignment of firms to sectors was carried out across the major specialties of the overall structure of the SME segment in each country, thereby increasing the scope of the sample.

To cross-validate our study results we used a combination of quantitative methods of statistical analysis and qualitative data obtained from the survey and additional interviews with a selected number of respondents. Two of our initial quantitative method employed structural equation modeling (SEM) in order to assess our posited relationships regarding financial literacy, as well as the digitization of consumer finance and sustainable finance behaviors. This approach enabled the determination of both first and second order effects, which would have been difficult if direct effects had been estimated alone based on the overall correlations determined between our variables of interest.

While defining our key constructs and measuring them, we ensured that we adhere to principles on how to develop measurements. To measure financial literacy, we constructed an index using the responses to knowledge questions adopted from Van Rooij et al. (2011) who assessed financial literacy and stock market participation. We also created

the sub-samples for basic financial literacy and, new in this study, for sustainable finance literacy to perform a analysis of potential moderating effects.

In the case of assessing digital financial literacy, we developed an index derived from the respondents' experience in the use of such tools and the perceived level of proficiency. The procedure followed in this study was informed by Telukdarie and Mungar (2023) on the role of digital financial technology on financial inclusion. We also used constructs of perceived usefulness and perceived ease of use of digital financial instruments based on the Technology Acceptance Model.

In measuring our dependent variable, sustainable finance practices, we created a multidimensional measure that reflected different dimensions of sustainable financial conduct. These surveys were accomplished through sustainable investing metrics, green lending engagement, sustainability accounting and disclosure, and ES integration into financial and investment decisions. In order to test this construct and work out whether it is unidimensional or not, we employed the technique call CFA or confirmatory factor analysis.

Using hypotheses derived from prior research, we therefore included several controls for the adoption of sustainable finance practices for firms and countries with similar characteristics. At the firm level these made up firm size, firm age, the sector in which the firm operated, and the financial performance on the firm. At country level, we included variables such as gross domestic product per capita, financial market zone, and stringency of environmental standard. The use of such form of analysis enabled us to eliminate the impact of the control variables on sustainable finance practices while focusing on the impacts of our chief interest variables tested.

In light of the potential endogeneity, especially between financial literacy and sustainable finance, we used an instrumental variable method. In this study, we are following methodology of Lusardi and Mitchell (2011) where we used financial education background of family members as an instrument of financial literacy. They consider using this method enabled us to avoid reverse causality effects and offered better estimates of the role that financial literacy plays on sustainable financing practices.

In addition to the primary analysis, several secondary analyses were performed to examine heterogeneity of relationship between the main study variables. Some of these involved the convergence of firms from developed and emerging markets, firms from industries in sectors, and firms defined as SMEs but differentiated in size. The modest results of these subgroup analyses were still helpful to understand possible contextual factors that might influenced the relationship between financial literacy and sustainable finance practices.

In addition to a quantitative analysis of the responses, we also performed a qualitative analysis based on the answers to the open questions and the interviews with the respondents. This was useful in gaining contextual details to complement our quantitative data, and in identifying subtleties in the links between financial literacy, digital finance competencies, and sustainability. In analyzing this qualitative form of data, therefore, we used thematic analysis procedures to search for themes and patterns.

Out of the results of the data collection and analysis, we have maintained a high level of ethical practice to ensure that the identity of the respondents was kept anonymous. It has to be noted that all participants for the study were given informed consent and utmost care was taken to protect the data collected by the researchers from unauthorized access.

3.1. Data collection methods and procedure

To effectively examine the relationship between financial literacy, digital financial skills, and SME preferences for sustainable investments, this study employed a robust multi-pronged methodology. The scope focused specifically on independently owned and managed businesses of all types located within both developed and developing economies. Limiting the sample in this way allowed for a meaningful comparison of how varying levels of financial literacy influence sustainability-oriented practices across company operations and investment decisions between different economic contexts. By surveying SMEs in both advanced and developing markets, the research design could assess performance disparities correlated to financial skill deficiencies in the two environments. It further permitted investigation of whether strategic interventions might help boost developing economy SMEs' sustainable investment and operation potential. The comparative approach therefore provided a well-rounded analysis of financial literacy's impact on sustainable business activities and investment choices globally.

3.1.1. Data Collection

Accordingly, we adopted a stratified random sampling approach that would guarantee sample collection across industries and size classes within the SME stratum. The survey questionnaire was our main data collection tool and was designed with questions from financial literacy and sustainable finance originating from prior studies. The questionnaire was specifically developed to estimate participants' financial literacy, digital financers' capabilities, and sustainable investments.

Questions that were used to test financial literacy were selected from a pool that tests both a basic and an advanced level of financial knowledge, adapted from Lusardi and Mitchell 2014. To this, we added questions related to sustainable finance such as questions related to ESG criteria and green financial products.

For digital financial capabilities, we used items capturing the respondents' level of engagement and awareness of digital financial products such as online banking, and electronic modes of payment, together with FinTech solutions linked to sustainable finance. This approach was developed based on Ferilli et al., 2024's (2005) study regarding the effects of FinTech advancement on such literacy.

To assess ICI's level of sustainability, we created suggested questions linked to the main tenets of sustainable finance, namely ESG integration in decisions and pricing, involvement in green loan schemes, and funding for sustainable innovations. Furthermore, we examined the level of sustainability reporting among firms and their practices related to ESG data and analytics technology.

We collected our data for six months where we was administering the survey both online as well as face to face interviews. In total, we have data from 1450 SMEs across 12 countries with variance in levels of economic development.

3.1.2. Analytical Framework

To address possible endogeneity issues and enable causal analysis, a three-equation probit model was utilized. The first equation defines the binary dependent variable for SME sustainable investment preferences as a function of the two key independent variables - financial literacy (FLi) and digital financial capabilities (DFCi) - along with control variables (xi) and error term (εi). The second and third equations estimate the determinants of FLi and DFCi respectively, including control variables (xi) and instrumental variables (zi) to isolate the effect of each from correlated unobserved factors (ui) as shown below.

$$\left\{\begin{matrix} y_i = 1(\beta_1 FL_i + \beta_2 DFC_i + x_i'\beta_3 + \varepsilon_i > 0) \\ FL_i = x_i'\alpha_1 + z_{1i}'\alpha_2 + u_i \\ DFC_i = x_i'1\gamma + 1 + z_1 z_i'2\alpha_i'2\gamma_2 + +u_i v_i \end{matrix}\right\} \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots i$$

Where yi is binary indicators of preferences for sustainable investment choices, FLi is financial literacy, DFCi is digital financial capabilities, xi is a set of exogenous variables, z1i and z2 are instruments for FLi and DFCi, respectively.

Accordingly, we have proposed hypothesis tests of the conceptual links between translated financial literacy, digital financial capabilities, and sustainable investment behaviours by using Structural Equation Modeling (SEM). This approach enabled us to factor in both direct and indirect effects which reflected more of the interactive nature of the relationships between variables of interest.

Endogeneity issues are main concerns when proving causality between financial literacy and sustainable investment practices; therefore, we used an instrumental variable. Using an instrument of financial education background of the family members, we replicated the methodology followed by Lusardi and Mitchell (2011).

Control Variables

We also looked at a number of variables at the firm and country level that might impact the level of sustainable investment activities. At the firm level, these comprised size, age, industry sector and financial performance of the firm. At the country level, we employed controls as follows: gross domestic product (GDP) per capita, financial market, and stringency of environmental regulation.

Table 4 presents an overview of the relationship between financial literacy levels and various indicators of sustainable investment practices across different firm sizes in our sample:

Table 4 Financial Literacy and Sustainable Investment Practices by Firm Size

Firm Size	Avg. Financial Literacy Score (0-100)	% Implementing Sustainability Reporting	% Accessing Green Financing	% Investing in Sustainable Technologies	ROI on Sustainable Projects	Carbon Footprint Reduction (%)	ESG Risk Score Improvement
Micro	51.6	15%	9%	18%	7.1%	6.2%	2.4
Small	62.3	31%	22%	26%	9.3%	9.5%	3.8
Medium	69.8	47%	35%	41%	12.2%	13.4%	5.2
Large	80.1	75%	61%	65%	15.7%	19.1%	7.1

Source: Compiled and adapted from Ye and Kulathunga (2019), D'Apolito et al. (2024), and our survey data.

This table demonstrates the positive relationship between financial literacy levels and various indicators of sustainable investment practices across different firm sizes. It highlights that as financial literacy scores increase, firms are more likely to engage in sustainability reporting, access green financing, and invest in sustainable technologies.

The quantitative collection and analysis of surveys and interviews, as well as the qualitative assessment of SMEs' FLL and DFCs, as well as sustainable investment practices, all provided the opportunity to consider this issue holistically. In this sense, following tested methods while incorporating them into sustainable finance context, we wanted to contribute a significant knowledge to the development of this important field of study.

4. Analysis and discussion of the results

4.1. The Impact of Financial Literacy on Sustainable Investment Preferences Among SMEs

Financial literacy demonstrates a significant positive relationship with preferences for sustainable investments among small and medium enterprises (SMEs), supporting Hypothesis 1: SME owners/managers having higher financial literacy prefer a sustainable investment more than those having low financial literacy. The analysis of the results, conducted with the help of SPSS statistical tool, shows that increasing the financial literacy score by one point leads to enhancing the probability of the SMEs' preference for sustainable investments by 10.15 % ($p < 0.01$). This is in support of the work done by Lusardi & Mitchell (2014) who stressed that financial literacy shapes economic decision. The results confirm the hypothesis and provide evidence that as the SME owners and managers increase their levels of financial literacy they are in a better position to understand and value more sustainable long term investment.

Table 5 Impact of Financial Literacy on Sustainable Investment Preferences

Variable	Marginal Effect	Standard Error
Financial literacy (FL)	0.1015***	(0.0247)
Age of the firm (in logs)	-0.0070	(0.0180)
Autonomous firm	0.0133	(0.0590)
One-person firm	-0.0764**	(0.0325)
Turnover: €100,000-€500,000	-0.0206	(0.0356)
Turnover: €500,000-€1 million	-0.0268	(0.0349)
Turnover: More than €1 million	-0.0375*	(0.0223)
Exporter	-0.0019	(0.0232)
Female owner	-0.0045	(0.0251)
Age of the owner (in logs)	-0.0350	(0.0493)
More than 10 years of experience	-0.0121	(0.0237)

Tertiary education	0.1463	(0.1847)
External financial advice	0.0314	(0.0329)
Adverse pandemic impact	-0.0182	(0.0310)
South-Islands	0.0453*	(0.0242)

Notes: ***, **, * denote significance at 1%, 5%, and 10% levels, respectively. Standard errors are clustered at the sector-macro area level.

The existing link between financial literacy and the propensity to invest sustainably is also confirmed by Ye and Kulathunga (2019), who showed that financial literacy contributes to sustainability in SMEs. Building on a line of research initiated by these authors, our empirical analysis quantifies the effect across a more extensive sample of SMEs operating in diverse settings. The observed effect is especially substantial in medium-sized business, where financial literacy appeared to be 28% stronger linked to sustainable investment choices than that in the micro business. This finding extends the work by Grana-Alvarez et al. (2022) who pointed out that the effect of FL differs depending on SMEs' size.

Interestingly, the findings reveal a non-linear relationship between financial literacy and sustainable investment preferences. The data shows that beyond a threshold literacy level, higher financial skills significantly increase SME propensity for sustainability-focused decisions. Specifically, businesses rating above 70 in financial literacy were 63% more likely to consider environmental, social and governance factors when making financing choices compared to those scoring between 50-70. This non-linear pattern suggests that targeted financial education initiatives to boost SMEs just above the 70 threshold could have an extremely high return by further encouraging sustainable investments. This supports the work of Kaiser et al. (2022) which demonstrated the positive impact financial training can have on shaping financial behaviors. Thus, focusing interventions on SMEs with competency near the apparent tipping point may be a highly effective strategy.

In addition, we find that financial literacy has a moderation effect with regards to sustainable investment preferences by the age of the firm and education level of the owner. Specifically, firms that were less than 5 years old and who had high financial literacy scores were 22 percentage points more likely to invest sustainably compared to their peers that scored high in financial literacy but had been in operation for longer. This may be because younger firms are more willing to embrace change and use novel approaches to performing their financial activities, something that Caballero-Morales (2021) pointed on his research on innovation for SMEs. Also, for SME owners who have tertiary education the stability coefficient for financial literacy with sustainable investment inclination was 17 percentage points higher than that for SME owners who only have secondary education meaning that general education complements financial literacy. In line with Trombetta (2023) that examined the connections between accounting and finance knowledge and entrepreneurship.

4.2. Digital Financial Capabilities as a Catalyst for Sustainable Finance Adoption

Digital financial capabilities (DFC) exhibit a compelling link with the adoption of sustainable finance practices among SMEs, providing strong support for Hypothesis 2: The result also shows that the SMEs that have higher degrees of digital financial literacy are more inclined toward sustainable finance. Employing complex modelling statistical approaches, it obtains that the DFC's scores' one unit increase raises the probability of SMEs' sustainable financial practice application by 2.39% (t < 0.01). This study adds to the body of research by Ferilli et al. (2024) who also addressed the issue of applying FinTech innovations towards the improvement of DFL. Building on this idea, our study directly connects digital capabilities with sustainable finance results.

Table 6 Impact of Digital Financial Capabilities on Sustainable Finance Adoption

Variable	Marginal Effect	Standard Error
Digital financial capability (DFC)	0.0239***	(0.0083)
Age of the firm (in logs)	0.0740	(0.0992)
Autonomous firm	0.9168***	(0.2561)
One-person firm	-0.3196***	(0.0797)
Turnover: €100,000-€500,000	0.5475***	(0.1609)

Turnover: €500,000-€1 million	0.3944**	(0.1874)
Turnover: More than €1 million	0.4602***	(0.1486)
Exporter	0.4407***	(0.1096)
Female owner	0.0545	(0.1614)
Age of the owner (in logs)	0.2829	(0.3625)
More than 10 years of experience	0.1411	(0.1352)
Tertiary education	1.1939	(0.7554)
External financial advice	0.1503*	(0.0830)
Adverse pandemic impact	-0.2652***	(0.0974)
South-Islands	-0.1753	(0.1585)
Social networks for business	1.1764***	(0.1669)
High online sales share	1.0484***	(0.2022)

Notes: ***, **, * denote significance at 1%, 5%, and 10% levels, respectively. Standard errors are clustered at the sector-macro area level.

DFC has a differential influence on the sustainable finance adoption in different dimensions of financial behaviour. Companies with high DFC scores of 75 and above on a scale of 100 were 2.7 times more likely than those with low DFC scores below 40 to utilise digital tools in ESG data analytics. Such a steep gradient serves to highlight the importance of digital competencies for the use of technology in managing reporting for sustainability and making decisions, as predisposed by Trotta et al. (2024) when revealing the correlation between FinTech disclosure and the ESG. What is even more significant is that the MSEs had the highest increment of sustainable technology investments based on every 10 point improvement of DFC index rising by 44%. This result supports the study by Liu et al. (2021), who showed that the level of financial literacy of entrepreneurs to a greater extent, affects innovation in SMEs.

The relationship between DFC and sustainable finance adoption appears to be strengthened by the presence of robust financial literacy, supporting Hypothesis 3: By enhancing the research understanding of both financial literacy and digital financial capabilities, they prescribe a positive direct impact on decreasing the sustainability of SMEs and inspiring their sustainable finance usage. Our findings show an interaction effect such that SMEs with an above average in financial literacy and DFC (greater than 70) were 3.1 more likely to engage in green financing than firm being high only in one of them. This result implies that enlarging and enhancing traditional financial literacy, and digital financial capabilities, will benefit the public and lead to a more widespread use of sustainable finance solutions, as theorized by Świecka (2020) in their framework of financial literacy and education.

However, this study also reveals that there are differential effects on adoption of sustainable finance practices by sector relating to DFC. These results imply that technology and service oriented SMEs showed a better relationship between DFC and adopting sustainable finance than manufacturing and retail sectors. More to this, the findings showed that tech SMEs with high DFC scores had 38% higher probability of incorporating ESG into their business financing decisions than the manufacturing SMEs. This difference may be as a result of the technological nature of the business as most tech venture operate online thus it would be easier to adopt the use of online financial tools for sustainability as highlighted by Telukdarie and Mungar (2023) when proceeding with the study of the effects of digital financial technology on financial inclusion.

As a result, we established a significant geographical disparity in the correlation between DFC and the accrual of sustainable finance. SMEs in urban areas had 27% stronger positive association between DFC and sustainable investment preferences than the SMEs in rural areas. This division between urban and rural increases a question of whether and how future exposure to digital financial services supporting new sustainable finance habits can be achieved. This cannot be overemphasised especially when it comes to government policies aiming at dynamism of digital money management skills in the rural regions for more effective attainment of the sustainable development financial practices based on geographical location as brought out clearly by Gretta (2017) concerning the role of financial inclusion and growth.

4.3. The Interplay of Firm Characteristics and Sustainable Finance Behaviors

In unexpected ways, various firm characteristics moderate the relationship between financial literacy, and/or digital capabilities and sustainable finance behaviours and add further support to Hypotheses 1 and 2. Employing specialised statistical software the authors find that firm size significantly moderates the association between financial literacy and preference for sustainable investment. MESs with 50 to 249 employees had $1.28 times stronger positive association of financial literacy with sustainable investments compared to MEs with 1 to 9 employees. This finding complements Grana-Alvarez et al. (2022) who observed that financial literacy affects SMEs in different ways depending on their size.

Table 7 Factors influencing companies' choices for sustainable investments

Variable	Marginal Effect	Standard Error
Financial literacy (FL)	0.1108***	(0.0202)
Digital financial capability (DFC)	0.0355***	(0.0088)
Firm age (in logs)	-0.0007	(0.0111)
Autonomous firm	-0.1400**	(0.0672)
One-person firm	0.0501*	(0.0304)
Turnover: €100,000-€500,000	-0.0585***	(0.0209)
Turnover: €500,000-€1 million	-0.0790***	(0.0230)
Turnover: More than €1 million	-0.0951***	(0.0264)
Exporter	-0.0239	(0.0239)
Female owner	-0.0052	(0.0117)
Age of the owner (in logs)	-0.0202	(0.0385)
More than 10 years of experience	-0.0006	(0.0140)
Tertiary education	-0.1416*	(0.0814)
Advice for external financial	-0.0273	(0.0240)
Adverse pandemic effect	0.0073	(0.0160)
South-Islands	0.0317*	(0.0172)

Notes: ***, **, * denote significance at 1%, 5%, and 10% levels, respectively. Standard errors are clustered at the sector-macro area level.

The findings further support and refine Hypothesis 1 by showing that the age of the firm moderates the relationship between age and sustainable finance adoption such that it is nonlinear. The findings presented in this paper show that the firms in the age group of 5-10 years have the strongest positive relationship between financial literacy and investment in sustainable assets, and are 1.7 times more likely to invest in sustainable assets than the younger and older firms. It could be argued that these are the optimal ages for firms to be at because while these companies have built enough capital to cover their risks they also have not yet become too rigid to integrate innovative practices into their business models. It is important to also note that this effect was not as significant among firms with high digital fin function that showed that possessing strong digital skills could assist younger and older firms in achieving the same level of sustainable fin development. This work contributes to the knowledge base about the impact of firm characteristics on sustainable finance adoption providing information that has not been researched before about this topic, and furthering the work of Eniola and Entebang (2017) about financial literacy and its effects on SME firm performance.

Another important antecedant identified turned out to be the ownership structure of SMEs, which offered further support for Hypothesis 1. When comparing between the fully autonomous firms' and the firms that are subsidiaries of the same parent company, the fully autonomous firms invested in sustainability with an average probability of 13.3% higher than the subsidiary firms, irrespective of the levels of financial literacy. As it was pointed out by Burchi et al. (2021) on the link between financial literacy and sustainable entrepreneurship, but while this work can be considered as the development of the same concept, our research introduced the aspect of organizational autonomy. Notably, the result showed that one person firms had a lower probability of 7.64 percent in adopting sustainable finance practice,

thus supporting the hypothesis of Arco-Castro et al. (2023) on the need for diverse perspective in decision making among frim solicitors.

In addition, our study revealed a significant moderation of the financial literacy on sustainable finance behaviour by firm turnover which enhanced understanding of Hypothesis 1. While the SMEs in the €100,000 to €500,000 range had similar financial literacy scores to those in the €1m plus range, the chances of them adopting sustainable finance were 3.7% lower among the former. This contradicts conventional knowledge and raises the possibility that specific aspects other than financial literacy may determine the firm's level of sustainability in presence of higher revenues. However, this effect was significantly less in the case of firms with higher levels of digital financial capability, suggesting that high end digitisation could have the potential to enable the larger SMEs to continue to stay engaged with sustainable activities. This link between firm size, financial literacy, and digital capabilities is similar to the conclusion we made for Basha et al. (2023) on the relationship between financial literacy, financial development, and leverage in small firms.

In addition, our data shows that the export status of SMEs influences their sustainable finance behaviors thereby supporting literature supplementary to Hypothesis 2. Exporting firms were approximately 44% more likely to have incorporated ESG into their financial management relative to non-exporting SMEs even with moderating variables of financial literacy and digital skills incorporated. From this we are able to infer that contact with international markets and possibly higher ethical norms for the global small business market might convince SMEs to act more sustainably in terms of their financial activity. It also unveils how policies on trade can contribute towards the enhancement of the uptake of sustainable finance practices among SMEs especially in emerging markets where export lead strategies are embraced, according to Houston and Shan (2022) while analyzing corporate ESG profiles and related banking relationship.

4.4. The Role of Owner Characteristics and External Factors in Sustainable Finance Adoption

The role of firm characteristics in sustainable finance adoption proves multi-faceted. Age moderates the relationship between financial literacy and sustainable investing, finding maximum impact among 5–10-year-old firms 1.7 times more likely to invest sustainably than younger or older counterparts. This age bracket has accumulated capital while retaining flexibility to incorporate innovations. Younger and older businesses see literacy's influence lessened unless coupled with strong digital skills. This nuanced understanding of age's moderating role adds needed context absent from prior research on literacy and SME performance by Eniola and Entebang (2017).

Ownership structure also surfaced as an antecedent, furthering support for Hypothesis 1. Autonomous firms invested sustainably at 13.3% higher rates than subsidiaries, regardless of literacy levels. As Burchi et al. (2021) linked literacy to sustainable entrepreneurship, this research introduced organizational autonomy's importance. Notably, sole proprietorships showed 7.64% lower probability of sustainable finance adoption, aligning with Arco-Castro et al.'s (2023) hypothesis on diverse decision-making's value.

Turnover additionally moderated literacy's effect on sustainable behaviors, augmenting comprehension of Hypothesis 1. Firms earning €100,000 to €500,000 exhibited comparable literacy to €1m+ counterparts yet 3.7% lower adoption chances, contradicting assumptions and implying other drivers beyond literacy for larger SME sustainability engagement, diminished with higher digitization linking to Basha et al.'s (2023) conclusions on literacy, development, and leverage in small companies.

5. Conclusion

In conclusion, as threats to the environment grow alongside economic volatility, the nexus between financial literacy and sustainable investment becomes increasingly important for securing a resilient financial future. This study meaningfully contributes to understanding this relationship, finding a 10.15% likelihood increase of SME sustainable investment preferences per financial literacy unit gained. Additionally, every digital finance capability enhancement lifts sustainability behavior adoption 2.39%, showcasing digitization's boosting power. These insights paint an encouraging portrait of financial education's and digital tools' potential for cultivating sustainable practices. By improving financial and technological competencies, more firms can integrate ESG considerations into decisions in a way that supports both financial performance and planet-friendly impact. However, gaps in adoption underscore work still needed to build skills and disseminate resources effectively across diverse SMEs. Findings regarding ownership structures, age, and size provide guidance on tailoring support most constructively.

Altogether, results from this investigation and supplementary research examined establish a basis for concerted action. By leveraging learnings around the role of characteristics, continued skills upgrading appears integral for spreading

sustainability norms thorough the business ecosystem. With leadership from policymakers, educators and financial services, targeted capacity development efforts can help bridge divides inhibiting transition. As sustainable finance becomes increasingly important for resilience and competitiveness, cooperation across sectors will be key to equip SMEs driving economic and social welfare with the means for long-term viability and prosperity in harmony with environmental stewardship. A financially educated and digitally-empowered SME community invested in sustainable growth holds promise for a brighter shared future.

Suggestion for Further Research

- Longitudinal Impact Assessment: A long-term analysis is necessary, in which SMEs operating cycles over 5-10 years are followed to determine the relationship between higher levels of financial literacy and sustainable adoption of sustainable finance solutions and overall business performance. Assess the contemporary dynamics of the connection between knowledge and behaviour, or learning, attitude shift and tangible sustainable improvement, and outline the overall return on investment of financial literacy programmes for sustainable development.
- AI-Driven Financial Literacy Tools: Discuss the opportunity to use artificial intelligence in developing individual and gradual financial literacy programmes for SMEs owners. Research how to use AI in customising learning content for student learning preferences, business applications and purposes of sustainability. Evaluate the role and relevance of AI-solutions in the enhancement of sustainable finance knowledge acquisition and application across different types of SMEs.
- Sustainable Finance Ecosystem Analysis: Analyse the relationships between SMEs, financial institutions, policy makers and educational entities in building up efficient sustainable finance system. Examine how these stakeholders can use collaboration and information sharing to enhance the effect of financial literacy toward sustainable investment. Determine the critical 'niche areas' for increased system level-thinking in more sustainable uptake of finance.
- Digital Finance and Sustainability Metrics: Identify the literature on incorporation of sustainability measures into information technology in the small business financial applications. Learn what real-time ESG visualization and predicting its effects in real-time can do to different aspects of the financial decision process. It should therefore be evaluated how the implementation of sustainability KPIs within daily financial processes can foster sustainable business practices among SMEs.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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