BJM BRITISH JOURNAL of MANAGEMENT BRITISH ACADEMY OF MANAGEMENT

British Journal of Management, Vol. 0, 1–19 (2024)
DOI: 10.1111/1467-8551.12821

Do Digital Technologies Enable Firms that Prioritize Sustainability Goals to Innovate? Empirical Evidence from Established UK Micro-businesses

Halima Jibril,[1] Effie Kesidou[2] and Stephen Roper[3]

[1]Innovation and Research Caucus, Warwick Business School, University of Warwick, Coventry, CV4 7AL, UK,
[2]Department of Economics, Leeds University Business School, University of Leeds, Woodhouse, Leeds, LS2 9JT, UK, and
[3]Enterprise Research Centre, Innovation and Research Caucus, Warwick Business School, University of Warwick, Coventry, CV4 7AL, UK
Corresponding author email: E.Kesidou@leeds.ac.uk

This paper examines the importance of sustainability within firms' strategic goals and its links with innovation in the context of micro-businesses. Micro-businesses provide an appropriate context for investigating this relationship because, while they tend to prioritize social and environmental goals, they are also more likely to confront resource constraints that can restrict their capability to innovate. Building on goal-setting theory and the resource-based view (RBV) of the firm, we explore under what conditions established micro-businesses that prioritize *sustainability goals* are more likely to *innovate*. Using novel survey data on 4649 established micro-businesses in the UK, we examine the enabling role of *digital technologies*. Our results suggest that owner-managers who prioritize sustainability goals are significantly more likely to generate new product and process innovations. Moreover, we find that this effect is stronger when micro-businesses adopt digital technologies. Digital technologies enhance the capabilities of micro-businesses, strengthening the connection between sustainability goals and product and process innovation.

Introduction

Sustainability goals are increasingly recognized as a top policy priority, globally and across many countries, owing to the climate emergency (Mio, Panfilo and Blundo, 2020). Globally, there is growing pressure to combat emissions and to meet the UN Sustainable Development Goals (SDGs),[1] many of which are directly (e.g. goal 13 on climate action) or indirectly (e.g. goal 7 on affordable and clean energy) interrelated with climate change, or with more social aspects of sustainability such as responsible consumption and production (goal 12) and reduced inequalities (goal 10). Several countries have also developed sustainable development policies so as to ensure efficient management of resources, to promote the circular economy, and to reduce the health risks arising from pollution.[2] In the context of firms, *sustainability goals* refer to the integration of social and environmental issues into business operations (EC, 2020; OECD, 2015). These firm-level sustainability objectives form the basis of our study; they reflect firms' own goals related to improving the social and environmental benefits of their businesses.

Previous research has largely focused on sustainable innovation or eco-innovation, its drivers and performance outcomes. This literature highlights the positive effects of regulation (Jaffe, Newell and Stavins, 2002), sustainability strategy (Tsai and Liao, 2017), firms' external integrative capabilities (Dangelico, Pontrandolfo and Pujari, 2013, 2017) and dynamic internal

[1]See the 17 United Nations Sustainable Development Goals (https://sustainabledevelopment.un.org/?menu=1300).

[2]For instance, the EU (https://europa.eu/european-union/topics/environment_en) and the UK (https://www.gov.uk/government/publications/environmental-and-sustainability-policy) have developed environmental and sustainable policies.

capabilities (Demirel and Kesidou, 2019)[3] in driving eco-innovation. While these studies produced valuable insights, they tell us little about whether firms with sustainability goals are innovating more actively than firms without such goals.

This article, conversely, aims to shift this focus by investigating the significance of sustainability within the strategic goals of firms and its relationship with innovation. This is crucial if we are to understand whether firms that prioritize sustainability goals are more likely to engage in innovation. Furthermore, we explore under what conditions established micro-businesses that prioritize sustainability goals are more likely to innovate.

Micro-businesses provide a particularly interesting context in which to consider this relationship because, although prior literature has identified them as more likely to prioritize social and environmental goals (Demirel et al., 2019), they are also more likely to face resource constraints which may limit their capability to innovate (Dey et al., 2020; Hockerts and Wüstenhagen, 2010; Hofmann, Theyel and Wood, 2012; Journeault, Alexandre Perron and Laurie Vallières, 2021). These constraints stem from the notion that being sustainable is costly, that it may require supply chain reconfiguration, that consumers might be unwilling to pay more for sustainable products, and that firms, therefore, need to make a choice between the social benefits of sustainability and its costs (Shrivastava and Tamvada, 2019; Nidumolu *et al.*, 2009). Such choices may, however, be easier to implement in micro-businesses – where ownership and control are strongly related – than in other larger firms. However, resource constraints may make actually delivering on innovation more difficult in micro-businesses, a constraint that may be eased where firms have adopted digital technologies and consequently have a richer knowledge base (Zhou et al., 2023). Also, despite the recent growth of research on sustainable entrepreneurship (e.g. Muñoz and Cohen, 2018; Shepherd and Patzelt, 2011), we know little about whether, and under what conditions, sustainability goals lead to innovation in established micro-businesses. This is partly due to the greater focus of research in the sustainable entrepreneurship literature on start-ups (Muñoz and Dimov, 2015).

We derive research hypotheses by building on goal-setting theory and the resource-based view (RBV) of the firm. Goal-setting theory suggests that setting specific and challenging goals can lead to improved performance (Locke and Latham, 1990). The rationale behind choosing goal-setting theory lies in its potential to shed light on the direct relationship between the level of importance a firm attaches to sustainability goals and its innovation outcomes. According to the RBV, a firm's resources and capabilities are key determinants of its competitive advantage and performance (Barney, 1991). RBV theory enriches our conceptual framework by emphasizing the moderating role of digital technologies in this relationship. Together, these theories offer a nuanced perspective on how micro-businesses can leverage sustainability goals and digital technologies for innovation.

Our theoretical hypotheses suggest that (i) a positive relationship exists between a firm's strength of focus on sustainability goals and the likelihood of innovation, and (ii) that digital technologies play a positive moderating role in the relationship between the importance of sustainability goals and innovation. First, we argue that established micro-businesses that attach greater importance to sustainability goals are more likely to generate product and process innovations compared with similar firms that place less emphasis on sustainability goals. Goal-setting theory postulates that setting challenging goals elicits more effort and higher performance (Locke, 1968). In the context of sustainability goals, this theory implies that micro-businesses with a strong emphasis on sustainability are more likely to generate innovation. By setting sustainability goals, these firms can develop a strategic plan, build the relevant capabilities, identify innovation opportunities, and prioritize the most promising ones (Schaltegger and Wagner, 2011). Goal-setting theory allows for a deeper understanding of how the prioritization of sustainability goals influences the innovation outcomes of micro-businesses.

Second, RBV theory is employed to explain the moderating role of digital technologies in the relationship between the importance of sustainability goals and innovation. The RBV points out that a firm's resources enable them to build unique capabilities, which other firms fail to reproduce (Peteraf, 1993), thereby allowing them to sustain their competitive advantage. In this context, the adoption of digital technologies is considered a resource that allows firms to renew and enhance their capabilities (Nambisan, 2017; Papadopoulos, Baltas and Balta, 2020). By integrating RBV, the research framework posits that micro-businesses prioritizing sustainability goals and embracing digital technologies are more likely to innovate compared with their counterparts without digital adoption. The integration of RBV theory into the conceptual framework adds a critical insight by highlighting the moderating role of digital technologies.

We test these hypotheses using an original dataset from the 2018 Micro-business Britain survey. Methodologically, we use a recursive bivariate probit model to estimate the relationship between firms' emphasis on sustainability goals and the probability of innovation. Our econometric approach allows us to some extent to address endogeneity problems arising from simultaneity. However, we are mindful about claiming

[3]See Klewitz and Hansen (2014) and Adams *et al.* (2016) for recent reviews.

causality, noting that this study is a first attempt in understanding the phenomenon of sustainability goals and digital technologies, and their link with innovation in micro-businesses. The uniqueness of this survey outweighs the caveats of survey data analysis. It allows us to explore and test empirically, with a large dataset of over 4500 firms, the relationship between sustainability goals, digital technologies and innovation amongst micro-businesses.

We make two main contributions to literature. First, we show that micro-businesses that place a greater emphasis on *sustainability goals* are more likely to *innovate*, irrespective of the type of innovation. This extends prior literature that has emphasized the link between sustainability and performance in general (De Mendonca and Zhou, 2019) and that between sustainability and innovation performance in particular (Adomako et al., 2023; Du, Yalcinkaya and Bstieler, 2016). Our study highlights that owner-managers who place greater emphasis on sustainability goals develop a strategic plan that allows them to renew their resources and capabilities. This, in turn, increases the chance that micro-businesses will innovate. Second, we consider the role of *digital technologies* as enabling firms to translate sustainability goals into innovation. While prior evidence suggests that digital technologies can contribute to generating efficiency gains[4] and sustaining competitive advantage[5] (Knudsen et al., 2021), less is known about the enabling role that digital technologies play in supporting innovation and facilitating micro-businesses to achieve their sustainability objectives (Müller, Buliga and Voigt, 2018; Schneider, 2019). We focus here on the adoption of a range of new digital technologies. We suggest that these technologies enable micro-businesses that prioritize sustainability goals to develop unique, socially complex and tacit capabilities. This, in turn, increases their likelihood of innovating and disrupting business as usual.

The argument proceeds as follows. The next section outlines our conceptual thinking and hypotheses, linking firms' goal-setting behaviour to innovation activity and the enabling role of digital technologies. This is followed by sections describing our data and estimation approach, and outlining the main empirical results. The final section summarizes our key findings, discusses the implications for policy and management practices, and outlines directions for future research.

[4]For example, a recent report by Be the Business (2020) points out that adoption of Customer Relationship Management technologies can increase productivity by approximately 25% (ONS, 2018).

[5] For instance, Knudsen et al. (2021) contend that digitalized firms that integrate Big Data and benefit from strong network effects are able to gain a sustainable competitive advantage.

Theoretical background and hypotheses

Sustainability in established micro-businesses

Achieving a broadly based transition towards sustainability will require effective adaptation by the large population of existing firms (Shevchenko, Lévesque and Pagell, 2016). Established businesses have some advantages over new entrants in terms of their organizational attributes (reliability, accountability), technology, and market legitimacy, but also face barriers to adaptation owing to inertia and rigidities (Kelly and Amburgey, 1991; Leonard-Barton, 1992). These rigidities make it more difficult for established firms to make moves towards sustainability, which are likely to require new investment, and significant adaptation in routines, management practices, and products and services. Large firms with stronger resource and managerial capabilities may be better able to make the sustainability transition by investing in the required innovation (Gomes et al., 2015). This transition is likely to prove more challenging for established micro-businesses (with 1–9 employees) whose technical, cognitive and managerial resources are more limited.

Established micro-businesses experience the liability of smallness, having limited internal resources and finding it difficult to access external resources (Lefebvre, 2022). One aspect of this is that micro-businesses are often led by a single owner-manager or partnership, limiting the diversity of leadership perspectives and related creativity and innovation (Miller et al., 2022). This also leads to uncertainty over the returns to implementing sustainability, or to myopia relating to future market trends. Micro-businesses are also subject to material constraints, finding it more difficult to access the financial and technical resources required for more sustainable business practices. This leads smaller firms to adopt 'resource-light' sustainability practices, or to simply not engage in allocating resources to enhance sustainability (Wong, Wong and Boon-itt, 2020). The combination of limited managerial and material resources makes it particularly difficult for owner-managers in established micro-businesses to pursue and deliver on sustainability goals. This combination of resource and organizational challenges informs the key components of our study. Despite these obstacles, however, previous research indicates that the adoption of sustainable business practices can help improve efficiency and deliver a competitive advantage for small businesses (Simpson, Taylor and Barker, 2004).

Sustainability goals

Goal-setting theory suggests that a person's goals, or conscious intentions, are an important determinant of individual performance, and that specific and challenging goals elicit more effort than general and easier goals (Locke, 1968; Locke and Latham, 1990). Pursuing goals related to sustainability is challenging: they require more complex stakeholder relations, pose serious reputational issues, and are associated with a perceived discrepancy between the creation and appropriation of private and social value (Hoogendoorn *et al.*, 2019). Therefore, attaching high importance to sustainability goals, a decision that may be driven by strong social or environmental aspirations, is likely to elicit greater effort from business leaders and employees than the pursuit of narrower economic goals.

Although goal-setting theory relates to individuals' goals and performance (Ren, Tang and Zhang, 2023), it might also be applicable at the organizational level, especially in the context of micro-businesses, where the entrepreneur's personal goals are strongly reflected in business goals (Schaltegger and Wagner, 2011).[6] Sustainability-minded owner-managers transfer their values to their enterprises[7] (Gagnon, 2012), and this contributes to organizational identity and organization culture. Owner-managers with a sustainability mindset also often use their enterprises to undertake sustainability initiatives that have a positive impact on the environment or society (Gagnon, 2012).

Sustainability goals and innovation

In this paper, we argue that firms that place a high emphasis on sustainability goals are more successful innovators. In line with goal-setting theory, which postulates that challenging goals elicit more effort than easier ones (Locke and Latham, 1990), we expect to observe that micro-businesses emphasizing sustainability will exert more effort in their strategic planning and in building unique and heterogenous capabilities for innovation. Our conjecture is that this happens because owner-managers that pursue challenging sustainability goals are more likely to develop a strategic plan to materialize their aspirations, despite the fact that strategic planning is not typical for small and medium enterprises (Wang, Walker and Redmond, 2007). Yet, strategic planning is more likely when owner-managers pursue primarily non-economic goals (Wang, Walker and Redmond, 2007). In the context of sustainability goals, firms attempt to reconcile the inevitable trade-offs between their economic objectives on one hand and non-economic objectives on the other hand by strategically planning to change traditional products and conventional business processes (Ardito et al., 2019; Cillo et al., 2019).

Strategic planning involves the setting of long-term organizational goals, the development of plans for the implementation of these goals, as well as the allocation of resources and the development of capabilities necessary for fulfilling these goals (Stonehouse and Pemberton, 2002). In the context of sustainability goals, strategic planning could allow firms to renew their resources and capabilities and to develop unique sustainability-orientated dynamic capabilities. Sustainability-oriented dynamic capabilities refer to the 'ability to integrate, build and reconfigure competences and resources to embed environmental sustainability into new product development to respond to changes in the market' (Dangelico, Pujari and Pontrandolfo, 2017, p. 490). Next, we delineate, using insights from the RBV, the underlying mechanisms that explain how owner-managers who emphasize sustainability goals develop unique sustainability-oriented dynamic capabilities that allow them to be more successful in introducing product and process innovations.

Sustainability goals and product innovation

Product innovation refers to the commercialization of new technologies or combinations of technologies that meet user or market needs (Utterback and Abernathy, 1975). It includes the first time a new product is introduced into the market, as well as the subsequent introduction of new varieties of a product. As mentioned above, owner-managers who pursue non-economic goals are more likely to develop a strategic plan to realize their aspirations (Wang, Walker and Redmond, 2007). In turn, strategic planning enables firms to renew their resources and capabilities so as to fulfil their goals (Stonehouse and Pemberton, 2002). Here, we propose that firms that place a high emphasis on sustainability goals can develop unique *market sensing sustainability-orientated* capabilities that enable them to offer new products, as follows.

First, market-sensing capabilities allow firms to address green consumption by anticipating rather than reacting to future market trends (Demirel and Kesidou, 2019). Schaltegger and Wagner (2011) suggest that new owner-managers who set environmental sustainability goals develop a deeper knowledge of environmental issues. This knowledge enables them to foresee opportunities for product innovation, making them more likely to introduce product innovations. However, this type of innovation may be particularly difficult for established

[6]For instance, Terpstra and Rozell (1994) find a positive relationship between the use of goal setting and organizational performance.

[7]Furthermore, Gagnon (2012) shows that entrepreneurs may vary in the importance they assign to sustainability. First, 'sustainability orientation' arises when an entrepreneur recognizes the worth of sustainability and develops a positive attitude towards it. 'Sustainability commitment' is characterized by a conscious attachment of the entrepreneur to the sustainability cause. The most intense attachment mode is 'sustainability identification', where entrepreneurs incorporate sustainability as part of their own identities and self-concepts.

micro-businesses, given their limited internal managerial and financial resources. The limited market power of micro-businesses may also make it more difficult for them to influence consumption patterns unless they work in partnership with larger organizations.

Second, firms with sustainability goals can promptly detect changes in user or market needs and offer varieties of an existing product, as they engage with diverse stakeholders (Bos-Brouwers, 2010; Rauter *et al.*, 2019). At its core, sustainability takes into consideration the needs of diverse stakeholders, including those that are uninvolved in a firm's decision-making processes such as the community at large (Adomako et al., 2023). Involving such external stakeholders may be particularly important for micro-businesses with limited internal resources. Sustainable product innovation therefore requires firms to prioritize sustainability goals. This enables them to engage in strategic planning and build socially complex sustainability-oriented capabilities for market sensing. In doing so, they are able to focus potentially limited resources and respond to the needs of a wide array of stakeholders, and at the same time make economic profits. Based on the above arguments, we expect that micro-businesses that regard sustainability goals as highly important are more likely to engage in product innovation than those that regard these goals as moderately important or unimportant.

H1: The likelihood of micro-businesses engaging in product innovation increases with the importance that these businesses attach to sustainability goals.

Sustainability goals and process innovation

Process innovation refers to *how* a product or service is produced or delivered (Reichstein and Salter, 2006). It may relate to technological aspects or to more organizational aspects of process innovation, such as changes in supply chain, purchasing, personnel, or management practices (Walker, 2014). In line with goal-setting theory, we suggest that owner-managers who place a high emphasis on sustainability goals are more likely to develop a strategic plan. This enables them to renew their *technological and/or organizational sustainability-orientated capabilities*, and in doing so benefit from process innovations arising from production and organizational efficiencies as follows.

First, owner-managers who incorporate sustainability goals in their businesses place value on continuous improvement to enhance production and operations efficiency and reduce resource use. As Gagnon (2012, p. 12) suggests: 'continuous improvement is indeed a goal directed behaviour to a series of ever challenging goals which push and pull individuals and enterprises forward to accomplishment'. This is likely to be reflected in a stronger focus of micro-businesses' limited resources on improving operational efficiency and higher levels of process innovation.

Second, the influence of owner-managers' emphasis on sustainability goals will be particularly strong in micro-businesses, which are often led by a single owner-manager or small leadership team. Where these firms prioritize environmental sustainability, they will be able to develop tacit capabilities embodied in environmental management systems that focus on cost reduction and eco-efficiency, which may facilitate process innovation (Demirel and Kesidou, 2019). Alternatively, firms led by individuals or teams that prioritize social sustainability could develop unique capabilities by implementing ethical management practices (Hawn and Ioannou, 2016). This, in turn, might enable them to integrate into ethical supply chains.

In addition to these capabilities, Jaffe *et al.* (2005) argue that environmental issues represent an area in which we do not yet have sufficient technological advancements to achieve diminishing returns to innovative investments. The same argument can be extended to social and thus sustainability issues. This suggests that there is more scope to innovate for firms that are led by owner-managers with sustainability objectives that they embody in their firms' investment decisions. Overall, insights from the literature suggest that sustainability-oriented firms have better capabilities and scope for detecting profitable opportunities for new or improved processes. In sum, the above discussion suggests that micro-businesses that regard sustainability goals as highly important are more likely to engage in process innovation than those that regard these goals as moderately important or unimportant.

H2: The likelihood of micro-businesses engaging in process innovation increases with the importance that these businesses attach to sustainability goals.

Digital technologies as an enabler of innovation

Although goal-setting theory assumes that goals regulate action (Locke et al., 1981), it also suggests that we should not expect a direct correspondence between goals and action, as humans (or by extension micro-businesses) might lack the necessary delivery capabilities (Locke, 1968). We build on RBV theory to explain the moderating role of digital technologies in the relationship between the importance of sustainability goals and innovation. The RBV explains that differences in firms' competitiveness arise from variations in their internal resources, leading to unique, tacit and difficult to imitate capabilities (Barney, 1991; Peteraf, 1993). In this context, the adoption of digital technologies is considered a resource that allows firms to renew and enhance their capabilities and knowledge base (Nambisan, 2017; Papadopoulos, Baltas and Balta, 2020; Zhou et al., 2023).

Consistent with the RBV, we argue that adopting digital technologies can enhance the capabilities of micro-businesses, strengthening the connection between sustainability goals and innovative actions.

There is little consensus on what constitutes 'digital technologies' (PwC, 2017, p. 8). This divergence reflects the wide variety of digital technologies that are available to firms – such as cloud-computing, artificial intelligence (AI), machine learning, etc. It may also reflect the different roles that digital technologies can play in the innovation process, namely as digital artifacts, digital platforms or digital infrastructure[8] (Nambisan, 2017). Next, we turn our attention to the role of digital technologies in enhancing the likelihood of firms that prioritize sustainability goals to produce product and process innovations.

Digital technologies as an enabler of product innovation

Digital technologies enable firms to incorporate new functionalities (e.g. a digital component, application or media content) into new or existing products (Kallinikos, Aaltonen and Marton, 2013). Consistent with the RBV (Barney, 1991), this allows firms to build unique sustainability-oriented capabilities (Demirel and Kesidou, 2019), which other firms fail to reproduce (Peteraf, 1993), and so develop product innovations.

In the case of firms that consider sustainability goals to be important for their business, adopting digital technologies, such as customer relationship management (CRM) systems, enables micro-businesses to receive continuous and timely feedback from customers. The potential for such digital engagement may be particularly important for micro-businesses, which have small leadership teams and therefore more limited personal networks than larger firms. Here, customer feedback could play a particularly important role in strengthening the market-sensing capabilities of firms and drive the introduction of new varieties of product innovations with pro-social and pro-environmental features appealing to customers (Barnett and Salomon, 2012). Prior literature has underlined that enhancing such socially complex capabilities (Barnett, 2007) increases a firm's reputation, credibility and competitiveness (Barney, 1991). Overall, the preceding discussion indicates that digital technologies moderate the relationship between the importance of sustainability goals and product innovation.

H3: Digital technologies positively moderate the link between the importance that micro-businesses attach to sustainability goals and product innovation.

Digital technologies as an enabler of process innovation

In line with the RBV of the firm, we propose that adopting digital technologies enables micro-businesses with sustainability goals to develop tacit sustainability-oriented capabilities that enable them to change the technological and organizational aspects of their innovation process. For firms that place a high importance on sustainability goals, the adoption of digital technologies can lead to process innovations, such as smart production manufacturing. This refers to embedding digital technologies into the production system. As a result, digital technologies could lead to process innovations that entail improved resource use and the reduction of production times, with beneficial energy savings (Alcayaga, Wiener and Hansen, 2019). Cloud-computing, for instance, allows businesses to reduce fixed IT costs, enabling them to adopt a cost-effective business model,[9] while the adoption of AI allows firms to make faster and more precise decisions, leading to cost savings (Plastino and Purdy, 2018).

Furthermore, digital technologies can help micro-businesses to overcome internal resource constraints and transform their organizational and technological processes by facilitating their integration into circular economy models and ethical supply chains. Circular economy models reduce the negative externalities of production and increase production and operation efficiencies (Rejeb et al., 2022). The use of digital technologies and data tracking over the life cycle of products can support efficient resource forecasting, which, in turn, reduces production costs, waste, and emissions (Alcayaga, Wiener and Hansen, 2019). Supply chains can also become more efficient when micro-businesses adopt digital infrastructure technologies, such as integrated planning and production systems (Zeng et al., 2017). In sum, the above discussion suggests that digital technologies moderate the relationship between the importance of sustainability goals and process innovation.

[8]Digital artifacts include the digital components (software, hardware or applications) of a new product or service (Nambisan, 2017). They are incorporated in a wide range of personal devices (e.g. applications on smartphones) and home appliances or automobiles (Lusch and Nambisan, 2015). A digital platform refers to a set of services offered by a single firm (the platform leader), who hosts an ecosystem of complementary products and services, including digital artifacts (Parker *et al.*, 2016; Tiwana *et al.*, 2010). Apple's iOS platform is a characteristic example of a digital platform that enables applications to run on their smartphones. Finally, digital infrastructure refers to digital technology tools and systems (e.g. cloud computing, social media, 3D printing, digital makerspaces, etc.) that augment the communication, collaboration and capabilities of a firm, which, in turn, may support innovation in small and medium enterprises (Nambisan, 2017).

[9]Berman *et al.* (2012) state that in a survey of 572 businesses across the globe, more than 31% of executives reported that such internal efficiencies were the key motivation for adopting cloud computing.

H4: Digital technologies positively moderate the link between the importance that micro-businesses attach to sustainability goals and process innovation.

Data and methods

Data

Our analysis uses data from the 2018 Micro-business Britain survey. This survey aimed to develop a representative picture of micro-businesses with 1–9 employees. The survey was conducted by telephone with the owners or managers of UK firms between February and May 2018, based on a commercially sourced sampling frame. It achieved a response rate of 9.3%. The survey covered 6254 UK micro-businesses established for more than 3 years.[10] Given missing observations for some relevant variables, our final sample consists of 4649 firms in most models. The survey asked about innovation and digital adoption as well as about key business characteristics, including having a sustainability objective. Appendix 1 provides a detailed profile of our data.

Dependent variables: Product and process innovation

Our dependent variables are two measures of innovation derived from questions asking firms if they had undertaken two forms of innovation over the past 3 years: product innovation and process innovation. The innovation measures are binary variables that take the value of 1 if the respondent answered 'yes' to adopting the innovation, and 0 otherwise. The measure of product innovation is based on a survey question that asked firms whether they had 'introduced a new or significantly improved product or service' over the preceding 3 years. Process innovation is derived from a similar question, asking firms if they had 'improved forms of organisation, business structures or processes' over the last 3 years.

Independent variable: The importance of sustainability goals

Our main independent variable is related to the importance that firms attach to sustainability goals. Survey respondents were asked to rate, on a Likert scale of 1–5, how important it was 'to increase the social and environmental benefits of the business'. Sustainability goals were rated 'very important', 'fairly important', 'neither important nor unimportant', 'not very important' and 'not at all important'. We categorize firms as attaching a high importance to sustainability goals if they regarded these goals as 'very important' or 'fairly important'. We categorize firms as attaching a moderate or medium importance to sustainability goals if they regarded these goals as 'neither important nor unimportant'. Finally, we categorize firms as attaching no importance to sustainability goals if they regarded the goals as 'not very important' or 'not at all important'.[11] Our main independent variable is therefore ordered, taking the value of 0 if firms have no sustainability goal, 1 if firms have sustainability goals of moderate importance, and 2 if firms have sustainability goals of high importance.

In our analysis we consider the relationship between firms' sustainability goals at the time of the survey and innovation in the most recent 3 years. Innovation behaviours may vary depending on market conditions, but recent studies have suggested the strong persistence of corporate objectives in family businesses, particularly where these are still led by members of the founding family. This reflects the more long-term aspiration of many family-owned firms and their preference for stability rather than transformational change (Fang, Chrisman and Holt, 2021). The vast majority of the firms in our sample of micro-businesses are family-owned firms, accounting for 70% of the sample, with 82% still being led by the founder; this suggests the likely stability of firms' sustainability objectives. Such persistence in corporate objectives is also in line with the literature on organizational inertia, which argues that businesses are frequently subject to inertial forces, often related to rigidities in managerial cognition (Buyl, Boone and Matthyssens, 2011).

Moderating variables: Digital technologies

We investigate whether the adoption of digital technologies moderates the relationship between the importance attached to sustainability goals and innovating. The survey asks firms whether they use each of seven digital technologies, to create a series of binary variables: Customer relationship management (CRM) systems, E-commerce, Web-based accounting software, Computer-aided design software, Cloud-based

[10]Firms were excluded if they were charities, part of the public sector, or branches and subsidiaries of larger firms. To prevent small sample sizes within groups, firms with five to nine employees were over-sampled, as were firms from Northern Ireland and Wales. In our analysis, we use sampling weights to obtain representative results.

[11]This strategy, which results in three levels of importance of sustainability goals, is based on findings from unreported regressions using the full Likert scale; these regressions consistently showed that firms that regard sustainability goals as 'very important' or 'fairly important' are not significantly different from each other, and those that regard it as 'not very important' and 'not at all important' are also not significantly different from each other. Firms in the middle are distinct, however, and warrant a separate category. We prefer this parametrization because it captures the variation in the relationship between sustainability importance and innovation, while being less complex than a model incorporating all five categories.

computing, Artificial intelligence, and Machine learning. CRM systems analyse data about customers' history to improve customer relationships. E-commerce involves transactions through the company website. Web-based accounting is an accounting software that enables users to access accounting information from any internet-enabled device. Computer-aided design software enables the creation, modification or optimization of a design. Cloud-based computing involves using remote servers over the internet, available to many users, to store and process data. Artificial intelligence is the simulation of human intelligence by machines. Machine learning enables computers to learn with data, by progressively improving performance of a specific task. To investigate the moderating role of these technologies, we test whether the effect of the importance of sustainability goals on innovation differs for firms that adopt new technology relative to those that do not.

Control variables

We control for standard determinants of innovation. We include the size of the firm in terms of employment, because greater internal capabilities confer innovation benefits (Acs and Audretsch, 1988). We also control for the educational qualification of the business leader, as this can enhance absorptive capacity and hence innovation (Gray, 2006). Younger firms may be more likely to innovate (Huergo and Jaumandreu, 2004), so we control for the age of the firm. Involvement of the firm's original founder also influences innovation (Block et al., 2011; Lee, Kim and Bae, 2020), as do firm exports (Ganotakis and Love, 2011; Higón and Driffield, 2011), and having home-based business premises (Reuschke and Domecka, 2018). We also control for formal business planning, which has been positively linked to innovation (Lee et al., 2009). Mina et al. (2013) find that innovation influences the likelihood that firms seek and obtain external finance, so we control for firms' use of external sources of finance. In addition, external linkages (Rothwell and Dodgson, 1991), external networking (Love and Roper, 2009), and external collaboration for innovation (Laursen and Salter, 2006) increase the likelihood of innovating. We also include business objectives of the firm other than sustainability, the personal ambitions of the business leader, and the adoption of human resource (HR) management practices, as all of these factors are likely to influence firms' sustainability objectives. Finally, we include sector dummy variables to account for sectoral differences in the propensity to innovate. The list of all variables used in the analysis and a detailed description of how they are measured is provided in Appendix 2 (Table A), as are descriptive statistics (Table B) and correlation coefficients (Tables C and D).

Empirical approach

As discussed in the section 'Moderating variables: Digital technologies', our dependent variables are binary variables that indicate a firm's adoption of product or process innovation. Our model of choice here is therefore the probit model, which is appropriate in the case of binary response models (Wooldridge, 2010).[12] We use a recursive bivariate probit model to estimate the relationship between the importance of sustainability goals and the probability of innovation. The bivariate probit model is commonly used when there is reason to believe that an independent variable is endogenous to a binary dependent variable (Monfardini and Radice, 2008). The model forms part of the group of discrete-choice endogenous variable models (Heckman, 1978). The model jointly estimates two equations – the reduced-form equation for the endogenous regressor and the structural-form equation for the binary outcome of interest – thus:

$$y_{1i}^{*} = \beta_1 x_{1i} + \mu_{1i}, \tag{1}$$

$$y_{2i}^{*} = \beta_1 x_{2i} + \mu_{2i} = \delta_1 y_{1i} + \delta_2 v_{1i} + \mu_{2i}, \tag{2}$$

where y_{1i}^{*} and y_{2i}^{*} are unobserved latent variables relating to the discrete observed variables; x_{1i} and v_{1i} are vectors of independent variables; and the error terms μ_{1i}, μ_{2i} have a bivariate normal distribution with zero mean, unit variance and correlation coefficient ρ.

The dependent variable (innovation) is binary, and the potentially endogenous independent variable (importance of sustainability goals) is ordered, taking the values of 0, 1 and 2. We therefore estimate the bivariate model using conditional mixed process modelling (Roodman, 2011), which allows us to specify a probit model in the structural equation for innovation and an ordered probit model in the reduced-form equation for the importance of sustainability goals.

The joint estimation of these two equations can be avoided if the regressor is exogenous (Monfardini and Radice, 2008), in which case the model would reduce to two independent models (Greene, 2002). Therefore, testing for exogeneity in this model is important and can be achieved through estimating the correlation coefficient, ρ, between the error terms μ_{1i}, μ_{2i} (Monfardini and Radice, 2008). This test involves testing the null hypothesis that $\rho = 0$ against the alternative hypothesis that $\rho \neq 0$. Under the null, the regressor of interest, y_{1i}, is exogenous, and the model consists of independent equations that can be estimated separately (Greene, 2002). Under

[12] For robustness, we check our results using a linear probability model (LPM) that can also provide a good approximation of the average effects of our independent variables and offers ease of interpretation (Wooldridge, 2010) (see Appendix).

the alternative hypothesis, the regressor is endogenous, and joint estimation of the bivariate model is required to achieve consistent estimates of the parameters in the structural equation.[13] The empirical model we estimate is:

$$SG_i = \beta_1 Controls_i + \beta_2 x_i + \beta_2 z_i + \mu_{1i}, \qquad (4)$$

$$Innovation_{ji} = \delta_1 SG_i + \delta_2 Controls_i + \delta_3 Technologies_i + \mu_{2i},\ j = (1, 2), \qquad (5)$$

where SG_i is an ordered variable equal to 0 if the firm attaches no importance to sustainability goals, 1 if the firm attaches medium importance to sustainability goals, and 2 if the firm attaches high importance to sustainability goals. $Controls_i$ is a vector of individual and firm-specific control variables and sector dummies. z_i is a vector of additional variables used to identity firms' sustainability goals. These variables are the number of other business objectives of the firm (other than sustainability objectives), the number of personal ambitions of the business leader, and the breadth of HR practices adopted in the firm (as discussed above and detailed in the Appendix).[14] $Innovation_{ji}, j = (1,2)$ is a binary variable equal to one if a firm undertook product or process innovation; we estimate separate models for each type of innovation. $Technologies_i$ is a vector of binary variables equal to 1 if a firm has adopted each of the seven technologies (discussed above) and 0 otherwise.

In addition to the effects of SG_i on product and process innovation, we are also interested in the moderating effect of digital technologies, that is, how the effect of SG_i varies with the adoption of each of the seven $Technologies_i$. To do this, we divide firms with different levels of importance of sustainability goals into those that use digital technology and those that do not. We then examine differences in their propensity to innovate, and we use a chi-square test of equality between their marginal effects to test the statistical significance of these differences. Given that we have seven digital technologies, we examine the moderating effect of each technology separately:

$$SG_i = \beta_1 Controls_i + \beta_2 x_i + \beta_2 z_i + \mu_{1i}, \qquad (6)$$

$$\begin{aligned} Innovation_{ji} = {} & \delta_1 SG_{i,high\ with\ tech} \\ & + \delta_2 SG_{i,high\ without\ tech} + \delta_3 SG_{i,moderate\ with\ tech} \\ & + \delta_4 SG_{i,moderate,without\ tech} + \delta_5 SG_{i,None,with\ tech} \\ & + \delta_6 Controls_i + \delta_7 Technologies_i + \mu_{2i},\ j = (1, 2), \end{aligned} \qquad (7)$$

where $SG_{i,high\ with\ tech}$ captures firms that attach a high importance to sustainability goals and that have adopted a specific technology, and $SG_{i,\ high\ without\ tech}$ refers to firms that attach a high importance to sustainability goals but have not adopted the technology.

$SG_{i,\ moderate,\ with\ tech}$ and $SG_{i,\ moderate\ without\ tech}$ are analogously defined. $SG_{i,\ None,\ with\ tech}$ captures firms that attach no importance to sustainability goals but have adopted a specific technology. The base category, against which all firms are compared, is the group of firms that attach no importance to sustainability objectives and that have not adopted the technology. Our chi-square tests examine whether there is a statistically significant difference between the marginal effects of $SG_{i,high\ with\ tech}$ and $SG_{i,\ high\ without\ tech}$, and between the marginal effects of $SG_{i,\ medium\ with\ tech}$ and $SG_{i,\ medium\ without\ tech}$.

Results

The importance of sustainability goals and the probability of innovation

Table 1 shows the estimated marginal effects of the importance of sustainability goals on product and process innovation.[15] The marginal effects are estimated at variable means and represent the effect for the 'average' firm in the sample. The first two columns of Table 1 show the marginal effects from the structural and reduced-form equations for product innovation; the last two columns show the same for process innovation. Exogeneity tests for each model are reported at the bottom of the table; in all cases, we reject the null hypothesis that $\rho = 0$, indicating that the importance of sustainability goals is

[13] Unlike in ordinary least squares, the simultaneity in the model does not matter for the maximum likelihood estimation of the recursive bivariate model, because the endogenous nature of y_{1i} can be ignored in formulating the log-likelihood function. See Greene (2002) for the mathematical derivation of this result.

[14] Theoretically, identification in the bivariate probit model does not require the availability of additional instruments, and the same regressors can appear in both the structural and the reduced-form equation as long as they are sufficiently variable (Wilde, 2000; Monfardini and Radice, 2008). Here, we follow best practice and include these additional variables in the reduced-form equation; we believe them to be more strongly correlated with having a sustainability goal than with innovating.

[15] Estimating marginal effects from the bivariate model is fairly involved – the effects of variables that occur in both the reduced-form and the structural equation consist of their direct effect on innovation as well as their indirect effect through sustainability goals. The effect of sustainability goals on innovation is the difference in the probability of innovating with and without a sustainability goal, given the regressors in both the reduced-form and the structural equation. See Greene (2002) for a mathematical exposition of the marginal effects. Their interpretation is, however, straightforward.

Table 1. Average marginal effects of sustainability objectives on the probability of innovating

Variables	(1) Product innovation structural model	(2) Product innovation reduced form	(3) Process innovation structural model	(4) Process innovation reduced form
High importance of sustainability goals	0.113***		0.201***	
	(0.031)		(0.025)	
Medium importance of sustainability goals	0.053**		0.102***	
	(0.021)		(0.016)	
Degree	0.039***	0.005	0.002	0.005
	(0.014)	(0.014)	(0.013)	(0.014)
Employment	0.006*	0.004	0.007***	0.004
	(0.003)	(0.003)	(0.003)	(0.003)
Business age	−0.002***	0.001*	−0.001**	0.001*
	(0.000)	(0.000)	(0.000)	(0.000)
Home-based	−0.011	−0.036***	−0.042***	−0.033**
	(0.014)	(0.013)	(0.013)	(0.013)
Founder-managed	0.016	−0.003	−0.046***	−0.004
	(0.019)	(0.019)	(0.017)	(0.018)
Business plan	0.021	0.025	0.027**	0.024
	(0.015)	(0.016)	(0.013)	(0.015)
Exporter	0.057***	0.001	−0.022*	−0.001
	(0.014)	(0.014)	(0.013)	(0.014)
External finance	0.052***	0.030**	0.023*	0.029**
	(0.014)	(0.014)	(0.013)	(0.014)
Advice breadth	0.006	−0.000	0.028***	0.000
	(0.007)	(0.008)	(0.007)	(0.008)
Network breadth	0.013	−0.019*	0.014	−0.019*
	(0.010)	(0.010)	(0.010)	(0.010)
Collaboration breadth	0.114***	0.016**	0.071***	0.016**
	(0.008)	(0.007)	(0.005)	(0.007)
CRM system	0.061***		0.050***	
	(0.018)		(0.015)	
E-commerce	0.040***		−0.006	
	(0.014)		(0.013)	
Web-based accounting	0.015		0.051***	
	(0.014)		(0.013)	
Computer-aided design	0.007		−0.016	
	(0.016)		(0.014)	
Cloud-based computing	0.024*		0.038***	
	(0.015)		(0.013)	
Artificial intelligence	0.100***		0.002	
	(0.038)		(0.034)	
Machine learning	−0.004		0.001	
	(0.024)		(0.021)	
Primary sector	−0.144***	0.033	−0.050	0.036
	(0.038)	(0.036)	(0.035)	(0.036)
Manufacturing	−0.027	−0.017	0.005	−0.013
	(0.029)	(0.030)	(0.027)	(0.030)
Construction	−0.121***	−0.030	−0.017	−0.029
	(0.030)	(0.030)	(0.028)	(0.029)
Retail and wholesale	−0.020	−0.019	−0.031	−0.017
	(0.026)	(0.027)	(0.024)	(0.027)
Transport, accommodation, food	−0.099***	0.074**	−0.065**	0.077**
	(0.029)	(0.031)	(0.028)	(0.031)
Information, finance, real estate	−0.121***	−0.107***	0.019	−0.106***
	(0.029)	(0.028)	(0.026)	(0.028)
Professional, scientific services	−0.135***	−0.051*	−0.030	−0.052*
	(0.028)	(0.027)	(0.026)	(0.027)
Administrative services	−0.115***	−0.085***	−0.020	−0.087***
	(0.031)	(0.031)	(0.029)	(0.030)
Other business objectives breadth		0.109***		0.109***
		(0.007)		(0.007)

Table 1. (Continued)

Variables	(1) Product innovation structural model	(2) Product innovation reduced form	(3) Process innovation structural model	(4) Process innovation reduced form
Personal ambitions breadth		0.028***		0.028***
		(0.004)		(0.004)
HR practices breadth		0.037***		0.038***
		(0.004)		(0.004)
ρ	−0.11*		−0.29***	
p-value	0.041		0.000	
χ^2 test	7.29***		23.70***	
Prob > χ^2	0.007		0.000	
Observations	4649	4649	4649	4649

Notes: Standard errors in parentheses.
***p < 0.01, **p < 0.05, *p < 0.1.

endogenous in these models and that a bivariate model is needed to provide consistent estimates of the coefficients of sustainability goals.[16]

Product innovation

Column 1 of Table 1 shows that, relative to firms that attach no importance to sustainability goals, those that attach high importance to sustainability goals are 11.3 percentage points more likely to innovate. Attaching moderate importance to sustainability goals is associated with a 5.3 percentage point increase in the probability of product innovation. The difference between these two marginal effects is statistically significant (chi-square = 7.74, p = 0.006). This result suggests that the likelihood of engaging in product innovation increases with the level of importance attached to sustainability goals, and firms with the strongest sustainability goals are twice as likely to engage in product innovation as those with moderate sustainability goals.

For the main effects of digital technologies, Column 1 of Table 1 shows that having a CRM system is associated with 6.1 percentage point increase in the likelihood of engaging in product innovation. The effect is 4.0 percentage points for E-commerce, 2.4 percentage points for Cloud-based computing (although only marginally significant), and 10.0 percentage points for Artificial intelligence. By contrast, Web-based accounting, Computer-aided design and Machine learning have no statistically significant impact on the probability of product innovation.

Process innovation

Column 3 of Table 1 shows that, relative to firms that attach no importance to sustainability goals, firms that attach high importance to these goals are 20.1 percentage points more likely to engage in process innovation. The effect is 10.2 percentage points for firms that attach moderate importance to sustainability goals. As with process innovation, the effect for those with high sustainability importance is about double that of those with moderate sustainability importance. The difference between the two is statistically significant (chi-square = 23.70, p = 0.000).

As with product innovation, CRM systems and Cloud-based computing are important, increasing the likelihood of engaging in process innovation by 5 percentage points and 3.8 percentage points, respectively. Unlike for product innovation, however, Web-based accounting is important for process innovation; it is associated with a 5.1 percentage point increase in the probability of process innovation.

Overall, we find that for micro-businesses, the likelihood of engaging in product and process innovation increases with the importance attached to sustainability goals: firms attaching high importance to sustainability goals are twice as likely to innovate as those attaching moderate importance to these goals; the latter are themselves significantly more likely to innovate than those attaching no importance to sustainability goals. These results provide strong and consistent support for H1 and H2.

It is interesting to note the difference in the strength of the relationship between sustainability goals and the two forms of innovation. The marginal effects of both high and moderate importance of sustainability goals are stronger for process innovation (20.1

[16]We check the robustness of our models to using univariate probit models; all our results remain qualitatively similar, in that firms with high importance attached to sustainability goals are more likely to engage in both product and process innovation relative to those with moderate importance attached to sustainability goals. The marginal effects are smaller than those from the bivariate models. We also find that the digital technologies that are important for product and process innovation remain consistent across the bivariate and univariate models.

Table 2. Moderating role of technologies on the impact of sustainability importance on product innovation

Variables	CRM	E-Commerce	WBA	CAD	CBC	AI	ML
High importance with tech	0.151***	0.125***	0.111***	0.115***	0.119***	0.145***	0.077*
	(0.037)	(0.034)	(0.034)	(0.035)	(0.034)	(0.055)	(0.041)
High importance without tech	0.103***	0.109***	0.104***	0.101***	0.115***	0.106***	0.106***
	(0.032)	(0.032)	(0.033)	(0.032)	(0.033)	(0.031)	(0.031)
Medium importance with tech	0.132***	0.119***	0.069**	0.042	0.088***	0.216***	0.069
	(0.035)	(0.030)	(0.028)	(0.032)	(0.028)	(0.071)	(0.047)
Medium importance without tech	0.041*	0.034	0.042	0.053**	0.042	0.048**	0.049**
	(0.024)	(0.025)	(0.027)	(0.024)	(0.027)	(0.022)	(0.023)
Not important with tech	0.058*	0.040	0.014	0.009	0.036	0.219***	0.052
	(0.035)	(0.029)	(0.027)	(0.032)	(0.027)	(0.080)	(0.057)
Observations	4673	4673	4673	4673	4673	4673	4673
χ^2 test (*High importance*)	3.925	0.637	0.120	0.442	0.039	0.676	0.941
Prob > chi^2	0.047	0.425	0.729	0.506	0.842	0.411	0.332
χ^2 test 2 (*Medium importance*)	7.433	9.436	1.040	0.137	2.989	5.677	0.191
Prob > chi^2	0.006	0.002	0.308	0.712	0.083	0.017	0.662

Notes: χ^2 test (*High importance*) is a chi-square test of equality between the marginal effects 'High importance with tech' and 'High importance without tech'. χ^2 test 2 (*Medium importance*) is a chi-square test of equality between the marginal effects 'Medium importance with tech' and 'Medium importance without tech'. Standard errors in parentheses. CRM is Customer Relationship Management; E-Commerce is Electronic Commerce; WBA is Web-based Accounting; CAD is Computer-aided Design; CBC is Cloud-based Computing; AI is Artificial Intelligence; ML is Machine Learning. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. Covariates omitted for brevity.

percentage points and 10.2 percentage points) than for product innovation (11.3 percentage points and 5.3 percentage points). The stronger relationship with process innovation suggests that sustainability objectives are more strongly associated with continuous improvements in how a product or service is produced, which may lead to production efficiencies. While firms with strong sustainability objectives are still more likely to engage in product innovation, the relationship is weaker than for process innovation, and the focus of product innovation appears to be on product modifications or the introduction of new varieties of a product, rather than on pioneering the introduction of a new product or service. This may reflect, in part, the resource constraints of micro-businesses, which may limit the extent to which they can introduce radical innovations; instead, these businesses appear to be more likely to translate their sustainability objectives into improving their production processes and modifying existing products.

Some control variables prove important in both the reduced-form equations (Column 2 and Column 4) and the structural equations (Column 1 and Column 3), helping to provide interesting insights into how individual and firm characteristics influence sustainability goals and innovation. Home-based businesses are less likely to regard sustainability objectives as highly important and are less likely to engage in product innovation. By contrast, firms with access to external finance and those with a wide breadth of external collaboration are more likely to attach high importance to sustainability objectives and are more likely to engage in both product and process innovation.[17]

Digital technology as an enabler of innovation

Tables 2 and 3 explore the role of digital technologies in moderating the effect of sustainability goals on product and process innovation. Here, we are interested in whether the innovation effects of having sustainability goals of high or medium importance are amplified by adopting specific digital technologies.

Moderating role of digital technologies for product innovation

Table 2 shows the moderating effects of digital technologies for product innovation. As would be expected, statistically significant moderating effects occur for technologies that have a significant main effect on product innovation, that is, CRM, E-commerce, Cloud-based computing and Artificial intelligence (Table 1). However, the extent to which these technologies are important depends on whether the firm attaches high or moderate importance to sustainability goals.

Among firms that attach *high importance* to sustainability goals, those that adopt CRM have a higher probability of engaging in product innovation. Here, CRM-adopters are 15.1 percentage points more likely

[17]Although out of the scope of this study, in unreported regressions we checked the effects of sustainability importance on the degree of product innovation novelty. We found that both high and moderate levels of sustainability importance are more important for new-to-the-firm innovation than for new-to-the-market innovation.

Table 3. Moderating role of technologies on the impact of sustainability importance on process innovation

Variables	CRM	E-Commerce	WBA	CAD	CBC	AI	ML
High importance with tech	0.258***	0.186***	0.243***	0.187***	0.218***	0.201***	0.209***
	(0.031)	(0.030)	(0.030)	(0.030)	(0.030)	(0.050)	(0.035)
High importance without tech	0.187***	0.193***	0.211***	0.189***	0.184***	0.200***	0.199***
	(0.028)	(0.028)	(0.029)	(0.028)	(0.029)	(0.027)	(0.027)
Medium importance with tech	0.140***	0.116***	0.179***	0.083***	0.150***	0.099	0.089**
	(0.030)	(0.028)	(0.025)	(0.029)	(0.026)	(0.063)	(0.042)
Medium importance without tech	0.111***	0.102***	0.109***	0.111***	0.082***	0.116***	0.118***
	(0.022)	(0.023)	(0.026)	(0.022)	(0.026)	(0.020)	(0.021)
Not important with tech	0.011	−0.036	0.065**	-0.052*	0.002	0.034	0.010
	(0.030)	(0.028)	(0.026)	(0.031)	(0.025)	(0.078)	(0.053)
Observations	4673	4673	4673	4673	4673	4673	4673
χ^2 test (*High importance*)	11.69	0.175	3.256	0.00317	3.721	0.000	0.137
Prob > chi2	0.000	0.676	0.0712	0.955	0.0537	0.987	0.711
χ^2 test 2 (*Medium importance*)	1.085	0.331	8.913	1.103	8.285	0.0759	0.517
Prob > chi2	0.298	0.565	0.003	0.294	0.004	0.783	0.472

Notes: χ^2 test (*High importance*) is a chi-square test of equality between the marginal effects 'High importance with tech' and 'High importance without tech'. χ^2 test 2 (*Medium importance*) is a chi-square test of equality between the marginal effects 'Medium importance with tech' and 'Medium importance without tech'. Standard errors in parentheses. CRM is Customer Relationship Management; E-Commerce is Electronic Commerce; WBA is Web-based Accounting; CAD is Computer-aided Design; CBC is Cloud-based Computing; AI is Artificial Intelligence; ML is Machine Learning. ***$p < 0.01$, **$p < 0.05$, *$p < 0.1$. Covariates omitted for brevity.

to be product innovators, as compared with 10.3 percentage points for non-adopters. This difference is statistically significant (lower panels of Table 2). For all other technologies, firms attaching a high importance to sustainability goals maintain a similar likelihood of product innovation irrespective of technology adoption.

The moderating effects of digital technologies are much stronger among firms that attach *moderate importance* to sustainability goals; these firms appear to require digital technologies in order to maximize the likelihood of engaging in product innovation. Among firms with moderate sustainability goals, those that adopt CRM are about three times more likely to engage in product innovation relative to non-adopters (13.2 percentage points relative to 4.1 percentage points), those that adopt E-commerce are about four times more likely to engage in product innovation relative to non-adopters (12 percentage points relative to an insignificant 3.4 percentage points), those that adopt Cloud-based computing are twice as likely to engage in product innovation relative to non-adopters (8.8 percentage points relative to an insignificant 4.2 percentage points), and those that adopt Artificial intelligence are more than four times more likely to engage in product innovation relative to non-adopters (21.6 percentage points relative to 4.8 percentage points). All of these differences are statistically significant (lower panes of Table 2). Figure 1 provides a graphical representation of the moderating role of these four digital technologies for product innovation, showing marginal effects with 95% confidence intervals. These results provide support for Hypothesis 3.

Moderating role of digital technologies for process innovation

Table 3 shows the moderating effects of digital technologies for process innovation. As with product innovation, significant moderating effects occur for technologies with a significant main effect on process innovation, that is, CRM, Cloud-based computing and Web-based accounting (Table 1), and moderating effects vary by the degree of importance of sustainability goals.

Among firms with a *high importance* of sustainability goals, those that adopt CRM are more likely to engage in process innovation relative to non-adopters (26 percentage points relative to 18.7 percentage points); this difference is statistically significant (lower panes of Table 3). As with product innovation, only CRM moderates this relationship for firms with a highly important sustainability goal; other digital technologies have no significant moderating effect.

We continue to find stronger moderating effects for firms with a *moderate importance* attached to sustainability goals. Here, firms that adopt Web-based accounting are more likely to engage in process innovation relative to non-adopters (18 percentage points relative to 11 percentage points) and those that adopt Cloud-based computing are almost twice as likely to engage in process innovation relative to non-adopters (15 percentage points relative to 8.2 percentage points). These differences are statistically significant. CRM does not moderate the effect for those with moderately important sustainability goals. Figure 2 shows a graphical representation of these effects. These results are in line with H4.

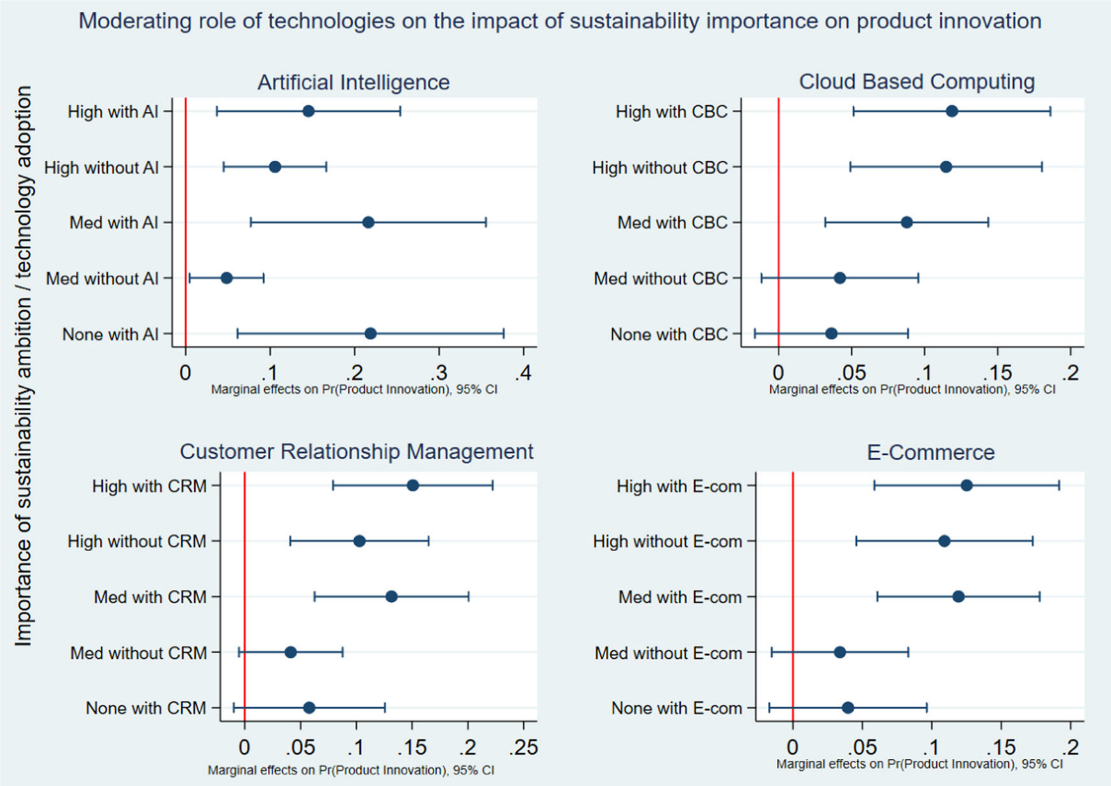

Figure 1. Moderating role of digital technologies on the impact of sustainability importance on product innovation
Notes*: Marginal effects with 95% confidence intervals. The base category is the group of firms that attach no importance to sustainability goals and that do not adopt the technology.*
[Colour figure can be viewed at wileyonlinelibrary.com]

Discussion and conclusions

This study makes two key contributions. First, we provide evidence suggesting that, for established micro-businesses, the likelihood of engaging in product or process innovation increases with the importance that these businesses attach to sustainability goals. Micro-businesses that regard sustainability goals as highly important are more likely to innovate than those that regard these goals as moderately important; the latter group of firms are themselves more likely to innovate than those that regard sustainability goals as unimportant. These findings are consistent with studies on sustainable entrepreneurship that underline the importance of sustainability for innovation (Gast, Gundolf and Cesinger, 2017). Prior studies also point out that such green ventures either create new markets for green products or services (York and Venkataraman, 2010) or introduce eco-innovations to niche markets (Hansen and Schaltegger, 2013). We contribute to this literature by emphasizing that sustainability-driven innovation is not the sole preserve of sustainability-oriented start-ups but can also occur where established firms have strong or even moderate sustainability goals.

Second, we find that digital adoption positively moderates the link between sustainability goals and innovation, although the moderating effect depends on the degree of importance attached to sustainability goals. Specifically, firms that perceive sustainability goals as moderately important are more likely to introduce a product innovation if they also adopt CRM systems, Cloud-based computing, E-commerce, or Artificial intelligence. This group of firms is also more likely to undertake process innovations if they also adopt CRM systems, Cloud-based computing, or Web-based accounting. By contrast, for firms that attach high importance to sustainability goals, only CRM matters in enabling product and process innovation; this group of firms remains highly likely to innovate irrespective of adopting other digital technologies. These results suggest that digital technology adoption plays an important role in compensating for less emphasis on sustainability goals among firms that regard the goals as moderately important. For instance, Web-based accounting or Cloud-based computing may help by reducing the costs or increasing the efficiency of firms' innovation activities (Gagnon, 2012), especially where the pursuit of sustainability objectives is not very strong. On the other hand, CRM software may serve to increase firms'

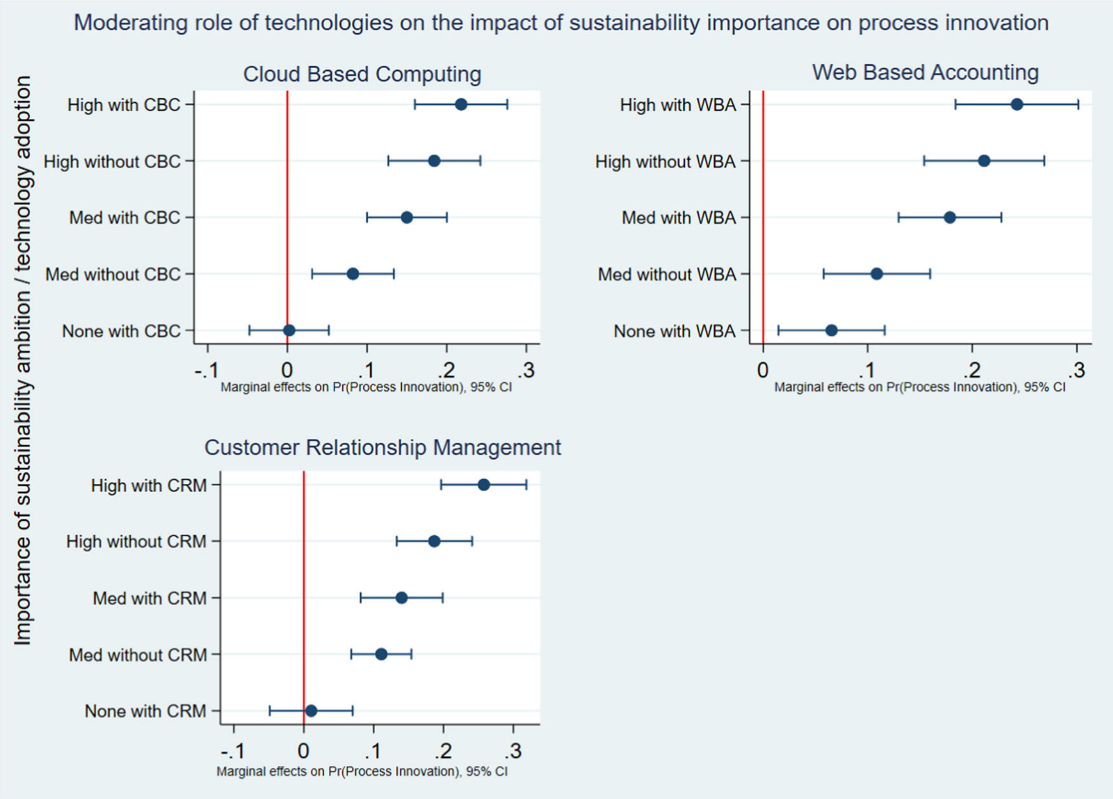

Figure 2. Moderating role of digital technologies on the impact of sustainability importance on process innovation
Notes*: Marginal effects with 95% confidence intervals. The base category is the group of firms that attach no importance to sustainability goals and that do not adopt the technology.*
[Colour figure can be viewed at wileyonlinelibrary.com]

ability to capture knowledge from their customers, which can shape innovation activity and help them to achieve their sustainability goals; this appears important for firms with high and moderate emphasis on sustainability goals.

In more conceptual terms, our results suggest the interplay between individual and firm-level goals, innovation outcomes and digital technologies. Digital technologies may support goal formation by enhancing firms' ability to capture external insights and by enriching firms' knowledge base (Zhou et al., 2023). Goal delivery may also be eased by digitally enhanced innovation capabilities. This suggests the importance of future conceptual development that recognizes the role of digital technologies (and access to such technologies) in both goal setting and achievement.

Our findings on the role of digital technologies as an enabler of innovation, for micro-businesses that prioritize sustainability goals, echo the findings of recent reviews (Ejsmont, Gladysz and Kluczek, 2020; Sharma, Jabbour and Jabbour, 2021; Vrchota et al., 2020) which have emphasized the positive links between digitalization and firms' adoption and implementation of sustainable business models. This conclusion is reflected in discussions of the UK's objective to achieve net zero carbon emissions by 2050, with Corfe (2020) identifying three main mechanisms through which digital technologies can positively contribute to reducing carbon emissions: (1) better environmental information and amelioration, which may guide better business and purchasing decisions; (2) reduced environmental impact of transportation through autonomous vehicles and road management systems; and (3) decarbonizing industry through logistics and energy-efficient cloud-based computing. Our own results suggest that digital adoption may have benefits of the type suggested by Corfe (2020) in the relatively short-term (2–3 years), but that the innovation benefits of digital technologies are stronger where firms' sustainability objectives are moderate. As Ghobakhloo (2020) suggests, wider societal benefits may take longer to emerge.

Our results contribute to policy debates on transitioning to a sustainable economy (Horbach, Rammer and Rennings, 2012; Jaffe, Newell and Stavins, 2002; Kesidou and Wu, 2020). Whilst prior literature points out that government policy is crucial in solving market failures associated with investments in natural or social capital (Kesidou and Demirel, 2012; Porter and van der Linde, 1995), it typically focuses on single policies (e.g. environmental policies are employed to solve market failures associated with pollution). However, a single policy instrument might not be enough to enable micro-businesses to turn sustainability goals into innovation. Instead, government policy could pursue a strategy of policy mix (Edmondson, Kern and Rogge, 2019), by fostering not only sustainability-oriented policies but also policies that induce digital adoption by firms or even coordinate infrastructure investments by [digital] cities. In doing this, our results suggest that such digital adoption interventions may be more useful for firms with relatively weak sustainability goals, suggesting scope for the targeting of such policies.

In more managerial terms, our results suggest the positive links between firms' sustainability goals, digital technologies and business innovation in micro-businesses, emphasizing the enabling effects of digital adoption. Promoting an awareness of the delivery benefits of digital technologies may encourage firms to embrace more ambitious sustainability goals, potentially supporting wider aspirations towards net zero. The enabling benefits of digital technologies need to be balanced, however, against potential negatives related to cyber-crime, data misuse, and the violation of digital property rights (Kim et al., 2011; Pirkkalainen and Salo, 2016). The increasing use of big data and AI have also been linked to issues with cognitive overload (Merendino et al., 2018), and to algorithmic biases related to gender and diversity (Draude et al., 2020). In the specific context of micro-businesses, where managerial resources are limited, firms' ability to capitalize on the advantages of digital technologies, and to counter the potential negatives, may be more limited than in larger firms. This may shift the balance of benefits and costs away from adoption in micro-businesses, and suggests the value in future research of exploring the extent to which negative effects may offset the positive influences of digitization in smaller firms.

Our study has a number of limitations. First, the cross-sectional nature of the Micro-business Britain data curbs our ability to identify cause-and-effect relationships. We do, however, account for aspects of endogeneity by using a recursive bivariate model. Second, whilst, as here, the potential benefits of digitalization for certain groups of firms have been widely stressed, less attention has been paid to its more negative implications (Gensch, Prakash and Hilbert, 2017). Third, while our study suggests the potential value to micro-businesses of sustainability goals, innovation and digital adoption, the wider sustainability effects of increasing digitization may also be significant. One recent study suggested, for example, that by 2040, data centres may account for a third of Denmark's 2017 national electricity consumption (Petrovic et al., 2020). Another study estimated that in 2018, video downloads generated around 1% of global emissions, equivalent to that of Spain, while information and communications technology itself accounted for 4% of global emissions, more than civil aviation (Efoui-Hess, 2019). Future studies could usefully look at the effects of digitization beyond the firm by, for example, accounting for Scope 3 emissions.[18]

References

Acs, Z. J. and D. B. Audretsch (1988). 'Innovation in large and small firms: an empirical analysis', *The American Economic Review*, **78**, pp. 678–690.

Adams, R., S. Jeanrenaud, J. Bessant, D. Denyer and P. Overy (2016). 'Sustainability-oriented innovation: a systematic review', *International Journal of Management Reviews*, **18**, pp. 180–205.

Adomako, S., C. Simms, D. Vazquez-Brust and H. T. T. Nguyen (2023). 'Stakeholder green pressure and new product performance in emerging countries: a cross-country study', *British Journal of Management*, **34**, pp. 299–320.

Alcayaga, A., M. Wiener and E. G. Hansen (2019). 'Towards a framework of smart-circular systems: an integrative literature review', *Journal of Cleaner Production*, **221**, pp. 622–634.

Ardito, L., J. Carrillo-Hermosilla, P. del Río and P. Pontrandolfo (2019). 'Sustainable innovation: processes, strategies, and outcomes', *Corporate Social Responsibility and Environmental Management*, **25**, pp. 106–109.

Barnett, M. L. (2007). 'Stakeholder influence capacity and the variability of financial returns to corporate social responsibility', *Academy of Management Review*, **32**, pp. 794–816.

Barnett, M. L. and R. M. Salomon (2012). 'Does it pay to be *really* good? Addressing the shape of the relationship between social and financial performance', *Strategic Management Journal*, **33**, pp. 1304–1320.

Barney, J. (1991). 'Firm resources and sustained competitive advantage', *Journal of Management*, **17**, pp. 99–120.

Be the business. (2020). The UK's Technology Moment – Why 2020 Can be the Year that Changed our Trajectory. Available from: https://www.bethebusiness.com/our-thinking/the-uks-technology-moment-why-2020-can-be-the-year-that-changed-our-trajectory-on-tech/. [Last Accessed 14/03/2024].

Berman, A. J., L. Kesterson-Townes, A. Marshall and R. Srivathsa (2012). 'How cloud computing enables process and business model innovation', *Strategy and Leadership*, **40**, pp. 27–35.

Block, J., D. Miller, P. Jaskiewicz and F. Spiegel (2011). 'Innovation in founder and family firms: entrepreneurial versus nurturer identities of owners', *Frontiers of Entrepreneurship Research*, **31**, pp. 437–450.

Bos-Brouwers, H. E. J. (2010). 'Corporate sustainability and innovation in SMEs: evidence of themes and activities in practice', *Business Strategy and the Environment*, **19**, pp. 417–435.

Buyl, T., C. Boone and P. Matthyssens (2011). 'Upper echelons research and managerial cognition', *Strategic Organization*, **9**, pp. 240–246.

Cillo, V., A. Messeni Petruzzelli, L. Ardito and M. Del Giudice (2019). 'Understanding sustainable innovation: a systematic literature review', *Corporate Social Responsibility and Environmental Management*, **26**, pp. 1012–1025.

Corfe, S. (2020). '4IR and the environment: how the fourth industrial revolution can curb air pollution and decarbonise the economy', *Social Market Foundation*. Available from: https://www.smf.co.uk/publications/4ir-environment-fourth-industrial-revolution-can-curb-air-pollution-decarbonise-economy/. [Last Accessd 14/03/2024].

Dangelico, R. M., D. Pujari and P. Pontrandolfo (2017). 'Green product innovation in manufacturing firms: a sustainability-oriented dynamic

[18]See https://ghgprotocol.org/sites/default/files/standards/ghg-protocol-revised.pdf

capability perspective', *Business Strategy and the Environment*, **26**, pp. 490–506.

Dangelico, R. M., P. Pontrandolfo and D. Pujari (2013). 'Developing sustainable new products in the textile and upholstered furniture industries: role of external integrative capabilities', *Journal of Product Innovation Management*, **30**, pp. 642–658.

De Mendonca, T. and Y. Zhou (2019). 'What does targeting ecological sustainability mean for company financial performance?', *Business Strategy and the Environment*, **28**, pp. 1583–1593.

Demirel, P. and E. Kesidou (2019). 'Sustainability-oriented capabilities for eco-innovation: meeting the regulatory, technology, and market demands', *Business Strategy and the Environment*, **28**, pp. 847–857.

Demirel, P., Q. C. Li, F. Rentocchini and J. P. Tamvada (2019). 'Born to be green: new insights into the economics and management of green entrepreneurship', *Small Business Economics*, **52**, pp. 759–771.

Dey, P. K., C. Malesios, D. De, S. Chowdhury and F. B. Abdelaziz (2020). 'The impact of lean management practices and sustainably-oriented innovation on sustainability performance of small and medium-sized enterprises: empirical evidence from the UK', *British Journal of Management*, **31**, pp. 141–161.

Draude, C., G. Klumbyte, P. Lücking and P. Treusch (2020). 'Situated algorithms: a sociotechnical systemic approach to bias', *Online Information Review*, **44**, pp. 325–342.

Du, S., G. Yalcinkaya and L. Bstieler (2016). 'Sustainability, social media driven open innovation, and new product development performance', *Journal of Product Innovation Management*, **33**, pp. 55–71.

Edmondson, D. L., F. Kern and K. S. Rogge (2019). 'The co-evolution of policy mixes and socio-technical systems: towards a conceptual framework of policy mix feedback in sustainability transitions', *Research Policy*, **48**, p. 103555.

Efoui-Hess, M. (2019). Climate crisis – the unsustainable use of online video: the Shift project. Available from: https://theshiftproject.org/wp-content/uploads/2019/07/2019-02.pdf [Last Accessd 14/03/2024].

Ejsmont, K., B. Gladysz and A. Kluczek (2020). 'Impact of Industry 4.0 on sustainability-bibliometric literature review', *Sustainability*, **12**, p. 29.

European Commission (EC). (2020). Green Action Plan for SMEs. Retrieved from: https://ec.europa.eu/growth/smes/business-friendly-environment/green-action-plan/ [Last Accessd 14/03/2024].

Fang, H. C., J. J. Chrisman and D. T. Holt (2021). 'Strategic persistence in family business', *Entrepreneurship Theory and Practice*, **45**, pp. 931–950.

Gagnon, M. A. (2012). 'Sustainable minded entrepreneurs: developing and testing a values-based framework', *Journal of Strategic Innovation and Sustainability*, **8**, p. 9.

Ganotakis, P. and J. H. Love (2011). 'R&D, product innovation, and exporting: evidence from UK new technology-based firms', *Oxford Economic Papers*, **63**, pp. 279–306.

Gast, J., K. Gundolf and B. Cesinger (2017). 'Doing business in a green way: a systematic review of the ecological sustainability entrepreneurship literature and future research directions', *Journal of Cleaner Production*, **147**, pp. 44–56.

Gensch, C.-O., S. Prakash and I. Hilbert (2017). 'Is digitalisation a driver for sustainability?' In T. Osburg and C. Lohrmann (eds), *Sustainability in a Digital World – New Opportunities through New Technologies*, pp. 117–129. Cham, Switzerland: Springer.

Ghobakhloo, M. (2020). 'Industry 4.0, digitization, and opportunities for sustainability', *Journal of Cleaner Production*, **252**, p. 21.

Gomes, C. M., J. M. Kneipp, I. Kruglianskas, L. A. B. Rosa and R. S. Bichueti (2015). 'Management for sustainability: an analysis of the key practices according to the business size', *Ecological Indicators*, **52**, pp. 116–127.

Gray, C. (2006). 'Absorptive capacity, knowledge management and innovation in entrepreneurial small firms', *International journal of entrepreneurial behavior & research*, **12**, pp. 345–360.

Greene, W. (2002). *Econometric Analysis*, 5th edn. New York, NY: Prentice Hall.

Hansen, E. G. and S. Schaltegger (2013). '100 per cent organic? A sustainable entrepreneurship perspective on the diffusion of organic clothing', *Corporate Governance*, **13**, pp. 583–598.

Hawn, O. and I. Ioannou (2016). 'Mind the gap: the interplay between external and internal actions in the case of corporate social responsibility', *Strategic Management Journal*, **37**, pp. 2569–2588.

Heckman, J. (1978). 'Dummy endogenous variables in a simultaneous equation system', *Econometrica*, **46**, pp. 931–959.

Higón, A. D. and N. Driffield (2011). 'Exporting and innovation performance: analysis of the annual small business survey in the UK', *International Small Business Journal*, **29**, pp. 4–24.

Hockerts, K. and R. Wüstenhagen (2010). 'Greening Goliaths versus emerging Davids – theorizing about the role of incumbents and new entrants in sustainable entrepreneurship', *Journal of Business Venturing*, **25**, pp. 481–492.

Hofmann, K. H., G. Theyel and C. H. Wood (2012). 'Identifying firm capabilities as drivers of environmental management and sustainability practices – evidence from small and medium-sized manufacturers', *Business Strategy and the Environment*, **21**, pp. 530–545.

Hoogendoorn, B., P. van der Zwan and R. Thurik (2019). 'Sustainable entrepreneurship: the role of perceived barriers and risk', *Journal of Business Ethics*, **157**, pp. 1133–1154.

Horbach, J., C. Rammer and K. Rennings (2012). 'Determinants of eco-innovations by type of environmental impact: the role of regulatory push/pull, technology push and market pull', *Ecological Economics*, **78**, pp. 112–122.

Huergo, E. and J. Jaumandreu (2004). 'How does probability of innovation change with firm age?', *Small Business Economics*, **22**, pp. 193–207.

Jaffe, A. B., R. G. Newell and R. N. Stavins (2002). 'Environmental policy and technological change', *Environmental and resource economics*, **22**, pp. 41–70.

Jaffe, A., R. Newell and R. Stavins, (2005). 'A tale of two market failures: Technology and environmental policy', *Ecological Economics*, **54**, pp. 164–174.

Journeault, M., A. Alexandre Perron and L. Laurie Vallières (2021). 'The collaborative roles of stakeholders in supporting the adoption of sustainability in SMEs', *Journal of Environmental Management*, **287**, p. 112349.

Kallinikos, J., A. Aaltonen and A. Marton (2013). 'The ambivalent ontology of digital artifacts', *MIS Quarterly*, **37**, pp. 357–370.

Kelly, D. and T. L. Amburgey (1991). 'Organizational inertia and momentum: a dynamic model of strategic change', *Academy of Management Journal*, **34**, p. 591.

Kesidou, E. and L. Wu (2020). 'Stringency of environmental regulation and eco-innovation: evidence from the eleventh Five-Year Plan and green patents', *Economics Letters*, **190**, p. 109090.

Kesidou, E. and P. Demirel (2012). 'On the drivers of eco-innovations: empirical evidence from the UK', *Research Policy*, **41**, pp. 862–870.

Kim, W., O. R. Jeong, C. Kim and J. So (2011). 'The dark side of the Internet: attacks, costs and responses', *Information Systems*, **36**, pp. 675–705.

Klewitz, J. and E. G. Hansen (2014). 'Sustainability-oriented innovation of SMEs: a systematic review', *Journal of Cleaner Production*, **65**, pp. 57–75.

Knudsen, E. S., L. B. Lien, B. Timmermans, I. Belik and S. Pandey (2021). 'Stability in turbulent times? The effect of digitalization on the sustainability of competitive advantage', *Journal of Business Research*, **128**, pp. 360–369.

Laursen, K. and A. Salter (2006). 'Open for innovation: the role of openness in explaining innovation performance among UK manufacturing firms', *Strategic Management Journal*, **27**, pp. 131–150.

Lee, J. M., J. Kim and J. Bae (2020). 'Founder CEOs and innovation: evidence from CEO sudden deaths in public firms', *Research Policy*, **49**, p. 103862.

Lee, S., B. Yoon, C. Lee and J. Park (2009). 'Business planning based on technological capabilities: patent analysis for technology-driven roadmapping', *Technological Forecasting and Social Change*, **76**, pp. 769–786.

Lefebvre, V. (2022). 'Performance, working capital management, and the liability of smallness: a question of opportunity costs?', *Journal of Small Business Management*, **60**, pp. 704–733.

Leonard-Barton, D. (1992). 'Core capabilities and core rigidities: a paradox in managing new product development', *Strategic Management Journal*, **13**, pp. 111–125.

Locke, E. A. (1968). 'Toward a theory of task motivation and incentives', *Organizational Behavior and Human Performance*, **3**, pp. 157–89.

Locke, E. A. and G. P. Latham (1990). *A theory of goal setting & task performance*. Prentice-Hall, Inc.

Locke, E. A., K. N. Shaw, L. M. Saari and G. P. Latham (1981). 'Goal-setting and task performance: 1969–1980', *Psychological Bulletin*, **90**, pp. 125–152.

Love, J. H. and S. Roper (2009). 'Organizing the innovation process: complementarities in innovation networking', *Industry and Innovation*, **16**, pp. 273–290.

Lusch, R. F. and S. Nambisan (2015). 'Service innovation: a service-dominant logic perspective', *MIS Quarterly*, **39**, pp. 155–175.

Merendino, A., S. Dibb, M. Meadows, L. Quinn, D. Wilson, L. Simkin and A. Canhoto (2018). 'Big data, big decisions: the impact of big data on board level decision-making', *Journal of Business Research*, **93**, pp. 67–78.

Miller, C. C., S. Chiu, C. L. Wesley, D. Vera and D. R. Avery (2022). 'Cognitive diversity at the strategic apex: assessing evidence on the value of different perspectives and ideas among senior leaders', *Academy of Management Annals*, **16**, pp. 806–852.

Mina, A., H. Lahr and A. Hughes (2013). 'The demand and supply of external finance for innovative firms', *Industrial and Corporate Change*, **22**(4), pp. 869–901.

Mio, C., S. Panfilo and B. Blundo (2020). 'Sustainable development goals and the strategic role of business: a systematic literature review', *Business Strategy and the Environment*, **29**, pp. 3220–3245.

Monfardini, C. and R. Radice (2008), 'Testing Exogeneity in the Bivariate Probit Model: A Monte Carlo Study', *Oxford bulletin of economics and statistics*, **70**, pp. 271–282.

Muñoz, P. and B. Cohen (2018). 'Sustainable entrepreneurship research: taking stock and looking ahead', *Business Strategy and the Environment*, **27**, pp. 300–322.

Muñoz, P. and D. Dimov (2015). 'The call of the whole in understanding the development of sustainable ventures', *Journal of Business Venturing*, **30**, pp. 632–654.

Müller, J. M., O. Buliga and K.-I. Voigt (2018). 'Fortune favors the prepared: how SMEs approach business model innovations in Industry 4.0', *Technological Forecasting and Social Change*, **132**, pp. 2–17.

Nambisan, S. (2017). 'Digital entrepreneurship: toward a digital technology perspective of entrepreneurship', *Entrepreneurship Theory and Practice*, **41**, pp. 1029–1055.

Nidumolu, R., C.K., Prahalad and M. R. Rangaswami (2009). 'Why Sustainability Is Now the Key Driver of Innovation', *Harvard Business Review*, pp. 57–64.

OECD. (2015). Environmental Policy Toolkit for Greening SMEs in the EU Eastern Partnership Countries. Retrieved from: https://www.oecd.org/environment/outreach/Greening-SMEs-policy-manual-eng.pdf.

ONS. (2018). Information and communication technology intensity and productivity. Office of National Statistics. Available from: https://www.ons.gov.uk/economy/economicoutputandproductivity/productivitymeasures/articles/informationandcommunicationtechnologyintensityandproductivity/2018-10-05. [Last Accessed 14/03/2024].

Papadopoulos, T., K. N. Baltas and M. E. Balta (2020). 'The use of digital technologies by small and medium enterprises during COVID-19: implications for theory and practice', *International Journal of Information Management*, **55**, p. 102192.

Parker, G., M. Van Alstyne and S. P. Choudary (2016). *Platform Revolution: How Networked Markets are Transforming the Economy–and How to Make them Work for You*. New York, NY: W.W. Norton Publishing.

Peteraf, M. A. (1993). 'The cornerstones of competitive advantage: a resource-based view', *Strategic Management Journal*, **14**, pp. 179–188.

Petrovic, S., A. Colangelo, O. Balyk, C. Delmastro, M. Gargiulo, M. B. Simonsen and K. Karlsson (2020). 'The role of data centres in the future Danish energy system', *Energy*, **194**, p. 116928.

Pirkkalainen, H. and M. Salo (2016). 'Two decades of the dark side in the information systems basket: suggesting five areas for future research', In ECIS 2016: *Proceedings of the 24th European Conference on Information Systems*. Tel Aviv, Israel, June 9-11, 2014 (Article 101). European Conference on Information Systems. http://aisel.aisnet.org/ecis2016_rp/101.

Plastino, E. and M. Purdy (2018). 'Game changing value from Artificial Intelligence: eight strategies', *Strategy and Leadership*, **46**, pp. 16–22.

Porter, M. and C. Van Der Linde (1995). 'Towards a new conception of environment–competitiveness relationship', *Journal of Economic Perspectives*, **9**, pp. 97–118.

PwC. (2017). Global Digital IQ® Survey. 10th anniversary edition. Available from: https://www.pwc.com/sk/en/publikacie/assets/2017/pwc-digital-iq-report.pdf [Last Accessed 14/03/2024].

Rauter, R., D. Globocnik, E. Perl-Vorbach and R. J. Baumgartner (2019). 'Open innovation and its effects on economic and sustainability innovation performance', *Journal of Innovation and Knowledge*, **4**, pp. 226–233.

Reichstein, T. and A. Salter (2006). 'Investigating the sources of process innovation among UK manufacturing firms', *Industrial and Corporate Change*, **15**, pp. 653–682.

Rejeb, A., Z. Suhaiza, K. Rejeb, S. Seuring and H. Treiblmaier (2022). 'The Internet of Things and the circular economy: a systematic literature review and research agenda', *Journal of Cleaner Production*, **350**, p. 131439.

Ren, S., G. Tang and S. Zhang (2023). 'Small actions can make a big difference: voluntary employee green behaviour at work and affective commitment to the organization', *British Journal of Management*, **34**, pp. 72–90. https://doi.org/10.1111/1467-8551.12597

Reuschke, D. and M. Domecka (2018). 'Policy brief on home-based businesses', *OECD SME and Entrepreneurship Papers*, No. 11, OECD Publishing, Paris. http://dx.doi.org/10.1787/abfe755f-en

Roodman, D. (2011). 'Fitting fully observed recursive mixed-process models with CMP', *The Stata Journal*, **11**, pp. 159–206.

Rothwell, R. and M. Dodgson (1991). 'External linkages and innovation in small and medium-sized enterprises', *R&D Management*, **21**, pp. 125–138.

Schaltegger, S. and M. Wagner (2011). 'Sustainable entrepreneurship and sustainability innovation: categories and interactions', *Business Strategy and the Environment*, **20**, pp. 222–237.

Schneider, S. (2019). 'The impacts of digital technologies on innovating for sustainability'. In N. Bocken, P. Ritala, L. Albareda and R. Verburg (eds), *Innovation for Sustainability Switzerland*. Palgrave Macmillan, pp. 415–433.

Sharma, R., C. J. C. Jabbour and A. Jabbour (2021). 'Sustainable manufacturing and industry 4.0: what we know and what we don't', *Journal of Enterprise Information Management*, **34**, pp. 230–266.

Shepherd, D. A. and H. Patzelt (2011). 'The new field of sustainable entrepreneurship: Studying entrepreneurial action linking "what is to be sustained" with "what is to be developed"', *Entrepreneurship Theory and Practice*, **35**, pp. 137–163.

Shevchenko, A., M. L. Lévesque and M. Pagell (2016). 'Why firms delay reaching true sustainability', *Journal of Management Studies*, **53**, pp. 911–935.
Shrivastava, M. and J. P. Tamvada (2019). 'Which green matters for whom? Greening and firm performance across age and size distribution of firms', *Small Business Economics*, **52**, pp. 951–968.
Simpson, M., N. Taylor and K. Barker (2004). 'Environmental responsibility in SMEs: Does it deliver competitive advantage?' *Business Strategy and the Environment*, **13**, pp. 156–171.
Stonehouse, G. and J. Pemberton (2002). 'Strategic planning in SMEs – some empirical findings', *Management Decision*, **40**, pp. 853–861.
Terpstra, D. E. and E. J. Rozell (1994). 'The relationship of goal setting to organizational profitability', *Group and Organization Management*, **19**, pp. 285–294.
Tiwana, A., B. Konsynski and A. A. Bush (2010). 'Platform evolution: coevolution of platform architecture, governance, and environmental dynamics', *Information Systems Research*, **21**, pp. 675–687.
Tsai, K. H. and Y. C. Liao (2017). 'Sustainability strategy and eco-innovation: a moderation model', *Business Strategy and the Environment*, **26**, pp. 426–437.
Utterback, J. M. and W. J. Abernathy (1975). 'A dynamic model of process and product innovation', *Omega*, **3**, pp. 639–656.
Vrchota, J., M. Pech, L. Rolinek and L. Bednar (2020). 'Sustainability outcomes of green processes in relation to industry 4.0 in manufacturing: systematic review', *Sustainability*, **12**, p. 5968.
Walker, R. M. (2014). 'Internal and external antecedents of process innovation: a review and manufacturing firms', *Industry and Corporate Change*, **15**, pp. 653–682
Wang, C., E. A. Walker and J. L. Redmond (2007). 'Explaining the lack of strategic planning in SMEs: the importance of owner motivation', *International Journal of Organisational Behaviour*, **12**, pp. 1–16.
Wilde, J. (2000). 'Identification of multiple equation probit models with endogenous dummy regressors', *Economics Letters*, **69**, pp. 309–312.
Wong, C. W. Y., C. Y. Wong and S. Boon-itt (2020). 'Environmental management systems, practices and outcomes: differences in resource allocation between small and large firms', *International Journal of Production Economics*, **228**, pp. 235–251.
Wooldridge, J. M. (2010). *Econometric Analysis of Cross Section and Panel Data*. Cambridge, MA: MIT press.
York, J. G. and S. Venkataraman (2010). 'The entrepreneur environment nexus: uncertainty, innovation, and allocation', *Journal of Business Venture*, **25**, pp. 449–463.
Zeng, H., X. Chen, X. Xiao and Z. Zhou (2017). 'Institutional pressures, sustainable supply chain management, and circular economy capability: empirical evidence from Chinese eco-industrial park firms', *Journal of Cleaner Production*, **155**, pp. 54–65.
Zhou, Y., C. Yang, Z. Y. Liu and L. Gong (2023). 'Digital technology adoption and innovation performance: a moderated mediation model', *Technology Analysis and Strategic Management*, pp. 1–16. https://doi.org/10.1080/09537325.2023.2209203

Halima Jibril is an Assistant Professor in Entrepreneurship and Innovation at the University of Warwick. Her current research focuses on SME innovation, performance and resilience, and the processes and impacts of innovation policy. She is part of the founding team of the Innovation and Research Caucus, a UK research centre working to improve evidence-based Research and Innovation funding strategies. Previously, she was a Research Fellow at the Enterprise Research Centre and The Productivity Institute.

Effie Kesidou is Chair in Economics of Innovation and Sustainability at the University of Leeds. Her research is interdisciplinary and has been published in: *Research Policy*, *Journal of Management Studies*, *Organization Studies, Journal of Product Innovation Management, Ecological Economics*, *International Journal of Production Economics*, *Journal of Business Ethics*, *World Development*, *International Journal of Operations and Production Management*, *Industrial and Corporate Change*, *Energy Economics*, etc. Her work is funded by the Economic and Social Research Council (ESRC), Biotechnology and Biological Sciences Research Council (BBSRC), European Commission, and Natural Environment Research Council (NERC).

Stephen Roper is Professor of Enterprise at Warwick Business School, founding Director of the Enterprise Research Centre (www.enterpriseresearch.ac.uk) and Co-Director of the Innovation and Research Caucus (I&RC). His main research interests relate to innovation and innovation policy, SMEs and related policy issues. His current work focuses on firm-level determinants of productivity, workplace mental health, well-being and productivity, and the micro-geography of innovation. Stephen is an Academician of the Academy of Social Sciences and a Fellow of the Royal Society of Arts (RSA) and the Institute of Small Business and Entrepreneurship (ISBE).

Supporting Information

Additional supporting information can be found online in the Supporting Information section at the end of the article.