Received: 1 April 2022 | Revised: 22 July 2022 | Accepted: 2 August 2022

DOI: 10.1002/bse.3226

RESEARCH ARTICLE

Business Strategy and the Environment

WILEY

Green manufacturing for sustainable development: The positive effects of green activities, green investments, and non-green products on economic performance

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[Correction added on 31 August 2022, after first online publication: The third author name has been corrected in this version.]

Abstract

This article explores the impact of green manufacturing practices, disentangled in green activities, green investments, and the type of product made, on the economic performance of firms. Using survey data collected by European Commission from European small- and medium-sized enterprises (SMEs), we adopt the self-determination theory to investigate the extent to which the number of green activities, green investments, and type of product made affects a firm's economic performance. We argue that consumers are affected by firms' green manufacturing practices in response to the pressing environmental issues affecting our era. Our results reveal that while the number of green activities has a positive effect on economic performance, the amount of green manufacturing investments has an inverted U-shaped relationship to economic performance and that this effect is positively moderated if a company also sells non-green products. Our study contributes to the literature on green manufacturing by dissecting the effect of green manufacturing practices on a company's economic performance. Our findings also provide managers with advice on the right balance of green practices that most benefit their companies.

KEYWORDS

economic performance, green activities, green investments, green manufacturing, green practices, green product

1 | INTRODUCTION

Society's growing interest in the "green" actions of firms is a consequence of the mounting concerns over the environmental issues currently threatening our world (Centobelli, Cerchione, & Esposito, 2020). Among the "Grand Societal Challenges"—that is, urgent open-ended global objectives that society is facing—those relating to the environment are some of the most pressing (Cappa et al., 2022; Foray et al., 2012; Papa et al., 2017; Pisello et al., 2017). In fact, ever since it became clear that the human activities are some of the most harmful factors in the deterioration of the environment and natural resources, environmental issues have become a priority for governments, organizations, and individuals (Ardito & Dangelico, 2018; Buysse & Verbeke, 2003; Michelino et al., 2019).

As a consequence, companies producing goods are moving toward the adoption of green manufacturing practices for a number of reasons: to benefit the environment and therefore society as a whole (Porter & Van Der Linde, 1995); to improve the brand image of

companies and therefore their reputation among consumers (Bird et al., 2007); and to attract customers that prefer environmentally responsible companies, which actually has the consequence of improving the economic performance of these companies (Bai & Sarkis, 2017; Böhringer et al., 2012). Green manufacturing implies environmental consciousness in manufacturing and related interventions (Rusinko, 2007), such as employing a broader range and quantity of green and renewable sources of energy (Lozano et al., 2018) and engaging in green supply chains (Liu & Xiao, 2020).

In the context of this growing interest in green manufacturing practices, how they affect the various facets of companies' performance, for example, environmental, operational, and economic performance, is attracting increasing attention (Bai & Sarkis, 2017; Bian et al., 2020; Böhringer et al., 2012; Chen et al., 2017; Li et al., 2017; Li et al., 2021; Li & Ramanathan, 2020; Liao & Shi, 2018; Miroshnychenko et al., 2017; Nath & Ramanathan, 2016; Orlando et al., 2020; Rusinko, 2007; Shen & Lin, 2020; Ye et al., 2021). In particular, in this study, we focus on economic performance to highlight the overall effect for companies (Li et al., 2017; Miroshnychenko et al., 2017). Previous studies found that green activities positively affect the different configurations of firms' economic performance (Li et al., 2017; Miroshnychenko et al., 2017), while it has also been found that while some green activities (minimizing waste, decreasing the consumption of hazardous and toxic materials, and reverse logistics) have a positive effect on economic performance, other green activities (environmental collaboration with suppliers, environmentally friendly purchasing practices, and ISO 14001 certification, which certifies that a company adopts an effective environmental management system) are not associated with the improvement of economic performance (Azevedo et al., 2011). Further, a detailed evaluation of the impact of green investments on economic performance has so far been overlooked. Moreover, extant research also fails to consider the effect of selling non-green products, that is, products that are not designed to minimize environmental impact during their whole life cycle (Dangelico & Pontrandolfo, 2010; Durif et al., 2010).

We contend that to comprehend the impact of on economic performance, the green manufacturing practices need to be disentangled in three different elements: the number of green activities undertaken, the size of green investments made, and the type of product made, that is, whether or not it is green. However, those three components need to be considered together rather than one at a time as what has been done so far by previous studies (e.g., Azevedo et al., 2011; Li et al., 2017; Miroshnychenko et al., 2017). As a result, we have explored the following research question: What is the effect of green manufacturing activities, green manufacturing investments, and non-green products on economic performance?

In this study, we grounded our hypothesis in self-determination theory (Deci & Ryan, 2000; Ryan & Deci, 2000), which posits that consumer satisfaction in this context is driven by the purchase of products whose production technology is considered green. Our study has been conducted using secondary data collected by the European Commission through the Flash Eurobarometer 456 survey (SMEs, resource efficiency and green markets). Previous studies have explored the effect of green manufacturing on economic performance using different variables. Some studies relied on return on assets (ROA) (Yadav et al., 2017), return on equity (ROE) (Aragón-Correa & Rubio-López, 2007; Wagner, 2005), Tobin's q (King & Lenox, 2002; Nakao et al., 2007), return on sales (ROS) (Wagner et al., 2002), and return on capital employed (ROCE) (Wagner et al., 2002). We argue that turnover increase is the right proxy to use when studying the effect of green manufacturing because it accurately assesses the immediate reactions of customers to such activities.

Based on the analysis of our final dataset, consisting of 9568 small- and medium-sized enterprises (SMEs), we found evidence that the number of green activities undertaken has a positive effect on a firm's economic performance, while the amount of green investment has an inverted U-shaped relationship effect on economic performance. Moreover, this inverted U-shaped effect is positively moderated by products that are not green. Therefore, we theorize and demonstrate that the adoption of green manufacturing practices can exert both a positive and negative effect on economic performance. It is positive because consumers appreciate environmentally friendly production, and they will likely prefer the products of companies that are more active in green activities, and it is negative when the level of green manufacturing investments is very high, because there is a ceiling effect after which consumers are no longer incrementally positively impressed, but rather may feel that too much effort is being devoted to this focus, to the detriment of the firm's other objectives. However, we argue that the latter effect can be reduced if a company offers non-green products. Indeed, in this case, the ceiling effect brought about by green investments is less strong, and customers react more positively to green investments. These results advance previous research into the green practices of companies by highlighting the importance of focusing on the number of activities, the quantity of investments, and the type of products when assessing the overall effect of green manufacturing practices on economic performance. In general, our study demonstrates the importance of adopting green manufacturing practices to improve the economic performance of companies, thanks to the assessments made by customers when evaluating products to purchase (Truffer et al., 2017). In this manner, we advance scientific understanding of the impact brought about by green practices, and we also provide managers with advice on the right balance that would benefit economic performance depending on the products offered.

We contribute to the advancement of research as follows. First, we reconcile mixed findings and views regarding the effect of green practices on economic performance by highlighting the fact that the number of green activities undertaken brings a positive effect while green manufacturing investment has both a positive and a negative effect that should be considered. In addition, we underscore the finding that there is a threshold point after which investment in green manufacturing is negative for firms, which shows managers they should not dedicate excessive effort to these practices. Moreover, we found that selling non-green products reduces the negative effect of excessive green manufacturing investment on company economic performance. Second, we highlight the view that self-determination

theory is the right lens to use when examining practices that may have an effect on economic and environmental issues. Further, we use turnover increase as proxy for economic performance.

The remainder of the paper is organized as follows: Section 2 provides theoretical background and hypothesis development; Section 3 lays out the data and methodology employed; Section 4 reports the results of our analysis; and Section 5 discusses the results and findings and provides managerial and policy implications and directions for future research.

2 | THEORETICAL BACKGROUND

Commitment to the natural environment has become a strategic action in current competitive scenarios (Franco et al., 2020). In addition to this, companies engage in green practices to improve their reputation in the eyes of customers (Griskevicius et al., 2010) and to attract a larger customer base, that is, consumers who are more in tune with environmental issues (Peattie, 2001) when they make their own assessments during purchasing decisions (Truffer et al., 2017). Indeed, the inclusion of environmental care in the corporate strategy of companies can improve their alignment with environmental concerns and societal expectations, including the global quest for companies taking a stand on social and ethical issues (Ambec & Lanoie, 2008; Buysse & Verbeke, 2003); these steps may significantly enhance the companies' standing and reputation, thus attracting customer purchases and consequently positively impacting economic performance.

However, the effect of green manufacturing practices on company performance has been debated at length. Porter claimed that green practices may have a positive effect on a firm's economic performance (Porter & Van Der Linde, 1995), and engaging in such actions is also a source of differentiation, enabling a company to establish itself as an "environmentally friendly" firm (Klassen & McLaughlin, 1996), which improves its reputation in light of growing environmental concerns. In response, companies disclose information about their green manufacturing practices in order to strengthen their relationships with their stakeholders (Groening et al., 2018; Olsen et al., 2014), and in this manner, firms also improve their economic performance further, because consumers are likely to reward them in turn, increasing demand for their products (Lin et al., 2013; Molina-Azorín et al., 2009; Rivera, 2002). On the other hand, some studies have found green practices can have a negative impact on a firm's economic performance since they may harm other operational goals (González-Benito & González-Benito, 2005), and they may take time to implement (Menguc & Ozanne, 2005).

Therefore, we argue that a deeper understanding of the impact of green manufacturing practices on company economic performance is needed. Following the example of similar work on responsible behavior in individuals (Cappa et al., 2019, 2020; Koo & Chung, 2014), we have based this study on self-determination theory (Deci & Ryan, 2000; Ryan & Deci, 2000) to explain why consumers are influenced by a sense of satisfaction when they contribute to a social aim, namely, addressing environmental issues in this case. Indeed, people are "active, growth-oriented organisms who are naturally inclined toward integration of their psychic elements into a unified sense of self and integration of themselves into larger social structures" (Deci & Ryan, 2000). For this reason, consumers buy products from environmentally friendly companies to satisfy their innate need for psychological sustenance, which is essential for their psychological growth and integrity (Ryan & Deci, 2000). This behavior generates self-satisfaction and enjoyment (Koo & Chung, 2014), which, in turn, positively impacts the economic performance of companies engaging in green manufacturing. Functional to this is the assessment of products on the market, because consumers evaluate their properties and impact before purchasing them (Truffer et al., 2017).

To comprehensively investigate the effects of green manufacturing practices on economic performance, we distinguish them into different components: the number of green activities, the quantity of green investments, and the type of product brought to market. We argue that evaluating the overall effect of these dimensions by jointly considering its individual effects will lead to a better understanding of how consumers assess corporate technologies, perceive their efforts, and decide to reward a company engaged in green manufacturing practices, leading to an increase in company sales. In the following subsections, we dissect the effects produced by each of the three aspects we have considered, positing three hypotheses.

2.1 | The impact of the number of green activities on economic performance

The first effect of green practices is the number of green activities a company undertakes. A company may pursue green manufacturing activities to a varying extent depending on its green commitment. Rather than considering each green activity singly, we contend that customers are able to evaluate the benefits and pitfalls of new technologies in manufacturing processes adopted by companies by considering all their green manufacturing activities as a whole. Consequently, the focus of these companies should not be on the single effect of each green activity—for example, "saving water" or "selling scrap materials"—but rather on the number of activities aimed at environmental sustainability; as such, a comprehensive effort is more valuable and understandable for ordinary citizens. Consumers can indeed feel satisfied and therefore be motivated to buy products if the number of green activities is considerable. In this respect, the magnitude of satisfaction, which lies at the heart of the decision to buy products from certain companies, according to self-determination theory (Deci & Ryan, 2000; Ryan & Deci, 2000), depends on the degree to which a company addresses environmental sustainability from different angles. Indeed, citizens are increasingly aware of sustainable development that encompasses different types of focus, ranging from resource efficiency to the circularity of product usage and disposal (Centobelli, Cerchione, Chiaroni, et al., 2020; Zou & Kim, 2009), and this affects their behavior as customers (Koo & Chung, 2014). In this sense, buying a product from a company that is

moderately green has a lower impact on consumer satisfaction and emotional well-being than purchasing a product from a company fully engaged in green activities.

Given the above, we expected that the number of green manufacturing activities undertaken by a company will have a positive effect on consumer satisfaction when buying products, resulting in an improved economic performance. Therefore, we posited the following first hypothesis:

> **H1.** The number of green manufacturing activities undertaken has a positive effect on a firm's economic performance.

2.2 | The inverted U-shaped relationship between economic performance and green investments

The second factor considered is the total value of a company's green investments, that is, the financial resources devoted to improving the environmental sustainability of their production system (Eyraud et al., 2013). This green spending is used to convert some production processes and reconfigure production flow and operations in order to meet with green manufacturing goals (Jaffe & Palmer, 1997; Madsen, 2009). In fact, green investments impact manufacturing processes and resource usage by reducing pollution, reducing waste, and recycling waste materials (Eyraud et al., 2013). Companies disclose information about their green investments to attract consumers who have stronger green consumption inclinations (Haws et al., 2014) and because green products improve the reputation of these companies (Bansal & Roth, 2000).

However, even though consumers appreciate the green manufacturing initiatives of firms and reward them by purchasing their products, excessive green investments may outweigh the positive effect on consumer perception. Indeed, some companies may overstate their green efforts in order to cover up other non-environmentally friendly actions, a phenomenon known as greenwashing, which can be defined as "corporate efforts to cloak environmental misconducts with claims of being environmentally friendly" (Caputo et al., 2021; Du, 2015). Due to this phenomenon, consumers may be skeptical toward firms that declare massive green investments, as they believe companies want to take opportunistic advantage of environmental trends (Nyilasy et al., 2014; Sinnewe et al., 2021). In addition, the negative effect of high levels of green investment may be due to a second factor. Consumers may feel that the massive investments required to undertake green activities may negatively affect product quality and performance, for instance by marginalizing other investments designed to improve product quality or processes (Chuang & Yang, 2014; Yang et al., 2012). In other words, based on the attention-based view (Ocasio, 1997; Ocasio & Joseph, 2005), excessive effort in one aspect of production may be perceived as dispersive for companies resulting in a confused technological assessment on the part of customers (Franco et al., 2020). Paying attention to a larger number of different aspects of green production, the effect of which is assessed in Hypothesis 1 may translate into a holistic approach to environmental sustainability without necessarily implying an excessive use of resources for this aspect. However, in the eyes of consumers, excessive investments in green activities may be risky due to excessive managerial attention to the environment at the expense of the firm's other goals.

Following logically on the above, and grounding ourselves in self-determination theory (Deci & Ryan, 2000; Ryan & Deci, 2000), we argue that customer satisfaction increases up to a point, after which additional investments will have a negative effect. The conjoint effect of these phenomena leads to a curvilinear effect of green investments on economic performance. Therefore, we posit our second hypothesis as follows:

> **H2.** Investment in green manufacturing has an inverted U-shaped effect on a firm's economic performance.

2.3 | The moderating effect of selling non-green products on green investments and the economic performance relationship

The environmental impact produced by the purchase of products and, consequently, customer satisfaction, is affected not only by efforts made in terms of green activities and by the amount of green investment but also by the nature of the product itself (Khan et al., 2021). In fact, it is possible to identify green products as those with outcomes that are designed to minimize their environmental impact throughout their whole life cycle (Dangelico & Pontrandolfo, 2010; Durif et al., 2010). As a consequence, companies may sell products that are green because they have an intrinsically less harmful environmental impact during their disposal or because they have a more positive impact on environmental and societal performance, without incurring in green investments (Ghisetti & Rennings, 2014). Vice versa, there may be companies that devote a great deal of resources to green activities but whose base product is less green by default. In line with the attention-based view (Ocasio, 1997; Ocasio & Joseph, 2005), we argue that customers will react more positively to investments in green activities for a product that is not green to begin with. In this case, investments are perceived as distracting less from the firm's other practices and are instead considered justified in order to balance out another product brought to the market that is not green. Applying self-determination theory (Deci & Ryan, 2000; Ryan & Deci, 2000), we contend that customers feel satisfied by efforts in the direction of green practices if they are not excessive, especially considering the type of the product, that is, green or non-green. Therefore, we contend that selling non-green products positively moderates the inverted U-shaped effect of investment in green manufacturing on economic performance. Thus, we posit our third hypothesis:

> **H3.** Selling non-green products positively moderates the effect that investment in green manufacturing activities has on economic performance.

TABLE 1 Description of variables

Variable	Type	Description	Min	Max
Turnover Increase	Categorical	Variation of turnover compared to the previous year	−1 (decreased)	1 (increased)
Green Activities	Discrete	Number of green activities undertaken	0 (no green activities)	9 (maximum effort in green activities)
Green investment	Categorical	% of turnover invested per year to be more resource efficient	1 (nothing)	6 (more than 30%)
Selling Non-Green Product	Categorical	Green product or service is offered	1 (yes)	3 (not now and not in the future)
Green Employees	Discrete	Number of employees in green activities	0	999
Northern Europe	Dummy	Geographical area	0	1
Southern Europe	Dummy	Geographical area	0	1
Eastern Europe	Dummy	Geographical area	0	1
Western Europe	Dummy	Geographical area	0	1
Nace1	Dummy	Mining and quarrying	0	1
Nace2	Dummy	Manufacturing	0	1
Nace3	Dummy	Electricity, gas, steam, and air conditioning	0	1
Nace4	Dummy	Water supply, sewerage, waste management	0	1
Nace5	Dummy	Construction	0	1
Nace6	Dummy	Wholesale, retail trade	0	1
Nace7	Dummy	Transportation and storage	0	1
Nace8	Dummy	Accommodations and food service	0	1
Nace9	Dummy	Information and communications	0	1
Employees	Discrete	Number of employees	1	60,000
Year of foundation	Discrete	Age of company	1	218
Cost Impact of Green Activities	Categorical	Impact on production of resource efficiency actions undertaken	0 (decrease in production cost)	2 (increase in production cost)
wex	Continue	Weight extrapolated population (enterprises)	1.182517	96,526.18

3 | DATA AND METHODS

To test the abovementioned hypotheses, we relied on the Flash Eurobarometer 456 survey titled "SMEs, resource efficiency and green markets," published on the European Union Open Data Portal (European Union, 2012). The survey is part of the Flash Eurobarometer Series of ad hoc thematic surveys conducted at the request of any service of the European Commission. In particular, the survey considered was conducted in 28 European Union countries among small- and medium-sized European companies employing between one and 250 employees, sampled from an international business database. The individuals were randomly selected, drawn from lists of companies provided by Dun & Bradstreet[1] database, which collect data of professional contacts (e.g., professional contact names, mailing addresses, phone numbers, and email addresses) of people who are employed at firms that operate in many sectors. Top level executives and managers were selected from this database as respondents. We argue that, as the survey is focused on SMEs, which are characterized by fewer complexities than big firms, these top-level executives can have a comprehensive view of the status of their companies and their actions. Interviews were carried out over the telephone using computer-assisted (CATI) software. In order to avoid any bias caused by translation errors, the basic bilingual English/French questionnaires were translated into the respective national language(s).

A total of 10,618 respondents, that is, company managers, were contacted in 2017. Given the shortage of publicly available data on green practices within companies, collecting data through a survey conducted at the European level is considered a suitable means of carrying out a detailed investigation into the topic.

Table 1 displays a detailed description of the variables employed in our analysis. The dependent variable, which indicates economic performance, is measured as the variation of total turnover (*Turnover Increase*) compared to the previous year, and it is defined as a categorical ordered variable with three possible outcomes: Increased, Remained the same, and Decreased (1, 0, and −1, respectively, in the survey). We relied on an increase in turnover as a proxy for economic performance,

[1]The Dun & Bradstreet Data Cloud contains data and insights on over 420 million organizations around the globe. Some of the information may be classified as personal information under various laws such as information relating to an individual (for example, a sole trader, a company director, a beneficial owner, a trustee, or a professional contact.) https://www.dnb.com/.

in line with previous studies conducted in contexts other than green practices (Thomsen & Pedersen, 2000; Wagenhofer, 2014), as it provides information on earnings from business activities, which is useful when assessing how well a company has performed in a period.

The first independent variable was measured through the number of green activities (*Green Activities*) undertaken by a company. It was calculated as the sum of the individual green activities that a company had put in place, which are, namely, saving water; saving energy; using renewable energy; saving materials; minimizing waste; selling scrap materials; recycling waste; and designing products that are easier to maintain, repair, or reuse. Therefore, the variable can assume values between zero and nine. The second independent variable was the percentage of turnover invested in green activities (*Green Investment*), which measures endeavors favoring green practices. Green Investment is an ordered categorical variable defined by six categories specifying the amount of the previous year's turnover that was invested in green actions: Nothing; Less than 1%; In the range of 1–5%; In the range of 6–10%; In the range of 11–30%; and More than 30% (0, 1, 2, 3, 4, 5, and 6, respectively, in the survey). The ordered categorical variable that controls for whether a company sells non-green products (*Selling Non-Green Products*) is the moderating variable in our study. It is defined by three levels: Yes, the company sells green products; No, but they are planning to do so in the future; and No, and they are not planning to do so in the future (1, 2, and 3, respectively, in the survey). Several control variables were added to improve the robustness of our analyses. First, the number of employees devoted to green activities (*Green Employees*) was included. Dummy variables to control for geographical areas were also included *Northern Europe* (the United Kingdom, Ireland, Sweden, Norway, Finland, Denmark, Iceland, Latvia, Lithuania, and Estonia); *Southern Europe* (Spain, Italy, Portugal, Greece, Cyprus, Malta, and Turkey); *Eastern Europe* (Poland, the Czech Republic, Hungary, Slovakia, Slovenia, Romania, Bulgaria, Moldova, Albania, Croatia, Montenegro, Serbia, and Macedonia); and *Western Europe* (France, Germany, the Netherlands, Belgium, Luxemburg, and Austria). There were also some respondents who did not respond to or belong to any of these geographical areas. In addition, we included nine dummy variables to control for their sector of production: mining and quarrying (*Nace 1*); manufacturing (*Nace 2*); electricity, gas, steam, and air conditioning (*Nace 3*); water supply, sewerage, and waste management (*Nace 4*); construction (*Nace 5*); wholesale and retail trades (*Nace 6*); transportation and storage (*Nace 7*); accommodations and food service (*Nace 8*); and information and communications (*Nace 9*). We also included a variable that considered firm size proxied by number of employees (*nempl*) (Damanpour, 1992). Moreover, firm age (*age*), computed as 2017 minus the incorporation year, was considered in order to control for company experience (Sørensen & Stuart, 2000). A variable measuring the impact on production costs of green activities undertaken was also included (*Cost Impact of Green Activities*), defined as a three-category ordered variable: Decreased; Unchanged; and Increased (0, 1, and 2, respectively, in the survey). Finally, we also considered a weight extrapolated population variable (*wex*), which extrapolates the actual universe (population aged 15 or more) for each country and corrects for the fact that most countries have almost identical sample sizes ($n = 1000$), no matter how large or small their populations are. Due to some missing values among the variables of interest in the initial sample, we obtained a final sample that included a total of 9568 observations with full information on the abovementioned variables for our analyses.

In order to analyze the effect of the independent variables on the categorical ordered dependent variable, we performed an ordinal logistic regression. We first controlled for the absence of multicollinearity by looking at the correlations (see Table 2). Then we performed regressions (Table 3) by adding only control variables first (Model 1), then the independent variables one at a time (Models 2 and 3), and finally the full model, which also included the moderating variable (Model 4). All the analyses were conducted using Stata version 14. We have also run the Harman's one-factor test, in line with previous studies that employed a survey database, to confirm the absence of common method bias issues (Fuller et al., 2016; Podsakoff & Organ, 2016).

4 | RESULTS

Table 2 reports the descriptive statistics and correlations for all the variables included in the study. Correlation values are all below .7, thus limiting multicollinearity concerns (Cohen et al., 2003; Franco et al., 2020). Table 3 shows the results of the analyses conducted. Model 1 is the baseline model including control variables. Model 2 adds the first independent variable (*Green Activities*). In this model, the coefficient of the variable *Green Activities* is positive and significant ($\beta = .085$, $p < .01$). Model 3 adds the second independent variable (*Green Investment*) and its quadratic term (*Green Investment * Green Investment*). The linear term *Green Investment* is positive and significant ($\beta = .547$, $p < .01$), while the quadratic term (*Green Investment Sq = Green Investment * Green Investment*) was found to be significant and negative ($\beta = -.061$, $p < .01$). Model 4 includes the interaction term (*Green Investment Sq * Selling Non-Green Product*). This is the full model for our study and shows that the number of green activities undertaken has a positive effect on the increase in company turnover, as the coefficient for *Green Activities* is positive and significant ($\beta = .032$, $p < .01$), thus providing support for Hypothesis 1. In addition, Model 4 shows the curvilinear effect of the second independent variable produced by its linear (*Green Investment*) ($\beta = .702$, $p < .01$) and quadratic term (*Green Investment * Green Investment*) on the increase in company turnover ($\beta = -.116$, $p < .01$), providing support for Hypothesis 2. This result is consistent with our prediction of an inverted U-shaped relationship between stakeholder perceptions of the effect of green production investment and a firm's economic performance. Indeed, although moderate investment in green manufacturing has a positive effect on a firm's turnover, this effect is lessened by excessive green investment, which consumers may consider a tease, thus affecting sales. Moreover, Model 4 shows that the fact a company sells non-green products (*Selling Non-Green Product*) positively moderates the inverted curvilinear relationship between green investments and the increase in turnover ($\beta = .026$, $p < .05$), in support of Hypothesis 3. The value of pseudo R^2 recorded in our model

TABLE 2 Descriptive statistics and correlation

Variable	Mean	SD	1	2	3	4	5	6	7	8	9
1. Turnover Increase	0.345	0.756	-								
2. Green Activities	3.42	2.22	.095	-							
3. Green Investment	2.40	1.10	.117	.222	-						
4. Selling Non-Green Product	2.28	0.902	−.069	−.244	−.165	-					
5. Green Employees	589.9	484.5	−.038	−.265	−.178	.386	-				
6. Northern Europe	.300	0.458	.050	−.019	−.028	−.034	−.018	-			
7. Southern Europe	0.179	0.383	−.044	.059	.046	.032	−.022	−.306	-		
8. Eastern Europe	0.313	0.463	−.025	−.167	.022	.080	.040	−.442	−.316	-	
9. Western Europe	0.180	0.384	.006	.133	−.049	−.075	−.007	−.306	−.219	−.316	-
1. Nace1	0.006	0.082	−.009	.006	.010	.001	−.004	.002	.005	−.001	−.017
11. Nace2	0.228	0.419	.028	.157	.099	.005	−.061	−.032	.037	.028	−.025
12. Nace3	0.007	0.085	−.009	.007	.048	−.044	−.018	.013	−.026	.016	−.005
13. Nace4	0.018	0.135	.003	.042	.075	−.044	−.072	.005	−.025	.033	−.023
14. Nace5	0.152	0.359	−.024	−.025	−.021	−.000	−.003	.024	−.033	.004	−.005
15. Nace6	0.297	0.457	−.022	−.038	−.083	−.059	.037	−.010	.011	−.003	.005
16. Nace7	0.056	0.230	.006	−.063	.043	.052	.019	.007	−.017	.028	−.019
17. Nace8	0.058	0.234	.020	.043	.030	−.057	−.006	−.004	.019	−.025	.005
18. Nace9	0.036	0.187	−.014	−.063	−.034	.046	.033	.012	.018	−.022	−.006
19.Employees	87.19	685.6	.007	.055	.020	−.022	−.020	−.009	−.009	−.008	.000
20.Age	26.30	24.570	−.025	.195	.032	−.078	−.063	.023	−.017	−.166	.172
21. Cost Impact of Green Activities	0.475	0.728	−.008	.096	−.021	−.010	−.015	−.011	.020	−.069	.043
22. wex	2411	7502	−.029	.023	−.023	.018	.023	−.144	.085	−.129	.011

TABLE 2 (Continued)

Variable	10	11	12	13	14	15	16	17	18	19	20	21	22
1. Turnover Increase													
2. Green Activities													
3. Green Investment													
4. Selling Non-Green Product													
5. Green Employees													
6. Northern Europe													
7. Southern Europe													
8. Eastern Europe													
9. Western Europe													
1. Nace1	-												
11. Nace2	−.045	-											
12. Nace3	−.007	−.046	-										
13. Nace4	−.011	−.075	−.011	-									
14. Nace5	−.035	−.230	−.036	−.058	-								
15. Nace6	−.053	−.354	−.055	−.089	−.276	-							
16. Nace7	−.020	−.132	−.021	−.033	−.103	−.159	-						
17. Nace8	−.020	−.135	−.021	−.034	−.105	−.162	−.060	-					
18. Nace9	−.016	−.105	−.016	−.026	−.082	−.126	−.047	−.048	-				
19.Employees	.013	.037	.011	.001	−.024	−.036	.010	−.011	.009	-			
20.Age	.011	.116	.014	.019	−.060	−.022	−.013	−.040	−.044	.091	-		

TABLE 2 (Continued)

Variable	10	11	12	13	14	15	16	17	18	19	20	21	22
21. Cost Impact of Green Activities	−.016	−.000	−.010	.006	.046	.000	−.016	.004	−.015	−.031	.001	-	
22. wex	.001	−.102	−.016	−.021	−.013	−.003	.003	.043	.051	−.034	−.057	.073	-

TABLE 3 Ordinal logistic regression with robust standard error (s.e.)

	Model 1	s.e.	Model 2	s.e.	Model 3	s.e.	Model 4	s.e.
Green Activities			0.085***	0.008	0.035***	0.010	0.032***	0.011
Green Investment					0.547***	0.068	0.702***	0.186
Green Investment Sq					−0.061***	0.012	−0.116***	0.031
Selling Non-Green Product							−0.065	0.100
Green Investment * Selling Non-Green Product							−0.083	0.075
Green Investment Sq * Selling Non-Green Product							0.026**	0.013
Green Employees	−0.000**	0.000	−0.000	0.000	−0.000	0.000	0.000	0.000
Northern Europe	−0.342**	0.137	−0.260*	0.138	−0.270*	0.154	−0.274*	0.161
Southern Europe	−0.677***	0.135	−0.621***	0.135	−0.678***	0.152	−0.697***	0.158
Eastern Europe	−0.438***	0.137	−0.485***	0.138	−0.513***	0.155	−0.525***	0.161
Western Europe	−0.467***	0.136	−0.407***	0.136	−0.420	0.152	−0.456***	0.158
Nace1	−0.320	0.236	−0.379*	0.241	−0.373	0.260	−0.363	0.272
Nace2	0.083	0.058	0.006	0.059	−0.087	0.067	−0.074	0.069
Nace3	−0.154	0.204	−0.183	0.204	−0.531**	0.241	−0.542**	0.243
Nace4	−0.147	0.127	−0.232**	0.128	−0.404**	0.146	−0.408***	0.149
Nace5	−0.214***	0.061	−0.250***	0.061	−0.319***	0.071	−0.309***	0.072
Nace6	−0.122***	0.054	−0.157***	0.054	−0.172**	0.063	−0.187***	0.065
Nace7	0.012	0.085	0.009	0.086	−0.096	0.100	−0.072	0.103
Nace8	0.077	0.086	0.006	0.086	−0.043	0.097	−0.052	0.100
Nace9	−0.171*	0.103	−0.151	0.103	−0.274**	0.117	−0.321***	0.121
Employees	0.000	0.000	0.000	0.000	−0.000	0.000	0.000	0.000
Age	−0.003***	0.000	−0.004***	0.000	−0.005***	0.000	−0.005***	0.000
Cost Impact of Green Activities	−0.029	0.023	−0.050**	0.023	−0.050*	0.026**	−0.053**	0.026
Wex	−0.000	2.81e-06	−0.000***	2.81e-06	−0.00**	3.15e-06	−7.59e-06**	3.20e-06
Pseudo R^2 (Mc Fadden)	.0062		.0102		.0164		.0181	
Pseudo R^2 (Cox-Snell)	.012		.020		.032		.035	
Pseudo R^2 (Nagelkerke)	.014		.023		.037		.041	
Wald chi-squared	152.98		258.72		327.01		339.78	
Number Obs	9568		9568		9568		9568	

Note: "Turnover Increase" is the dependent variable. The number of observations was 9568.
*stands for $p < .10$. **stands for $p < .05$. ***stands for $p < .01$.

is in line with the value found in previous studies that have used ordered logistic regression (Molodchik & Jardon, 2017; Sharma et al., 2017; Singh et al., 2012).

Finally, we ran additional tests to further support our results. The variable inflation factor (VIF) test was run to further check for multicollinearity. The VIF values are no greater than 1.0 and thus below the recommended maximum accepted value of 10, providing further evidence of the absence of multicollinearity (Lorenz et al., 1986; Pinelli et al., 2020). In addition, Harman's one-factor test was run to test whether the results of the survey were affected by common method bias. The result of the test shows that there are no problems related to common method bias in these data since the total variance

extracted by one factor is 5.477%, and this is less than the recommended threshold of 50% (Fuller et al., 2016).

5 | DISCUSSION

The present study has examined the relationship between a firm's economic performance and the adoption of green manufacturing practices, which are, specifically, the number of green activities undertaken, the value of green investments, and the type of product. While previous studies considered one green action at a time (Azevedo et al., 2011; Li et al., 2017; Miroshnychenko et al., 2017), we have provided an overarching perspective that considers all of them simultaneously. Moreover, we have contributed to a more detailed understanding of the effects of green manufacturing thanks to the fact that we have also considered the effects of green investments and of the type of product generated, thereby providing a holistic approach that advances current research regarding green manufacturing practices. In particular, we have dissected the effects of green manufacturing practices to produce a more comprehensive assessment of their impact in terms of the number of activities undertaken, investments in green manufacturing, and the type of product brought to market. Basing our analysis on self-determination theory (Ryan & Deci, 2000), which had previously been overlooked in this context, we contend that consumers react positively to green manufacturing practices that can benefit the environment and society because they feel more satisfied when they buy such products, and this is beneficial for company economic performance. We provided evidence that the number of green manufacturing activities, rather than the effect of the single ones as done so far (e.g., Azevedo et al., 2011; Li et al., 2017; Miroshnychenko et al., 2017), has a positive effect on a firm's economic performance, which shows that companies engaged in different green manufacturing activities will benefit more than those engaged in fewer activities. This evidence, consequently, should further encourage firms to undertake multiple green manufacturing activities. However, we argued and demonstrated that the number of green investments has both a positive and a negative effect on a firm's economic performance, reconciling previous findings that focused either on benefits or on drawbacks (Bian et al., 2020; Chen et al., 2017; Li et al., 2021; Liao & Shi, 2018; Orlando et al., 2020; Shen & Lin, 2020). This means that the green investments have an inverted U-shaped relationship with firm's economic performance. A moderate amount of green manufacturing investment has a positive effect on a firm's sales, whereas excessive green manufacturing investments can harm the strategic and competitive focus of the company, producing a negative effect on a firm's economic performance. In fact, when companies focus too much on a specific activity, they may harm their efforts regarding other activities. According to the attention-based view (Ocasio, 1997), companies have limited attention and resources to allocate, and therefore, excessive emphasis on a single aspect may be harmful to other aspects and overall product performance. Consequently, customers may find a significant effort in green investments satisfying, but they may be dissatisfied if they perceive it to be disproportionate. Moreover, we have also focused on the effect produced by the type of product offered, which was an aspect overlooked by previous studies. We have highlighted the finding that the curvilinear effect of green investments can be reduced if the company sells non-green products, because consumers perceive this as a way to restore balance. The company's green efforts counter the detrimental effects created by their other product(s), and thus, the negative effect of massive green investments on economic performance is reduced. In this respect, we regard consumers as being a good means for conducting assessments of green efforts in manufacturing processes. Since they reward companies by purchasing their product(s), they indirectly evaluate green manufacturing practices and the level of their implementation in the firm.

All in all, our results complement and enrich our understanding of the effect that green practices have on the economic performance of companies. Indeed, previous research had mainly focused on the impact of green practices on other aspects of corporate performance, that is, environmental performance (Chen et al., 2017; Li et al., 2021; Li & Ramanathan, 2020; Nath & Ramanathan, 2016; Orlando et al., 2020), operational performance (Belvedere & Grando, 2017; De Giovanni & Cariola, 2021), and the effectiveness of governmental subsidies (Bian et al., 2020; Liao & Shi, 2018; Shen & Lin, 2020). The abovementioned findings provide many contributions for scholars and practitioners, as outlined in detail in the following subsections.

5.1 | Contributions to theory

The study contributes to the ongoing academic debate surrounding green manufacturing management, in particular relating to research focused on the impact of green manufacturing practices (Azzone & Noci, 1998; Fouad Soubihia et al., 2015). Our study, in order to spell out their effects specifically on economic performance, breaks down green manufacturing practices into green actions, green investments, and the type of product made. Considering together the three abovementioned components of green manufacturing practices advances the scientific understanding of the overall effect brought about by green practices on companies' performance.

The second contribution of this study is the evidence that self-determination theory is a valid theoretical lens to use when considering the impact of green manufacturing practices on economic performance. It is clear that customers are increasingly motivated to buy the products of companies that attempt to tackle environmental issues, given the fact that the environmental related challenges we are facing are pressing. The sense of satisfaction provided by purchases that can benefit the environment and all of society is becoming increasingly decisive in company economic performance. Therefore, we contend that self-determination should be central when considering matters relating to the amount of company economic performance, since it plays a crucial role in motivating customer purchases.

Moreover, another contribution we have made is the evidence that there is a ceiling effect in green investment. Indeed, we have

highlighted an inverted U-shaped effect, meaning that there is a threshold after which a further increase in green investments has a negative effect on the economic performance. This is due to the fact that customers may not be more satisfied with the products of a company that invests too much in green activities, because, as described by the attention-based view (Ocasio, 1997; Ocasio & Joseph, 2005), companies can lose their focus on other product qualities. This effect is moderated by the product type, meaning that the negative effect is attenuated if another product sold is not green, because customers view greater investments positively in this case. As a result, depending on the product type, it is possible to identify different levels of optimal green manufacturing investments; this enriches our understanding of the impact of green activities on economic investments.

A further contribution of our study is its focus on turnover as the variable of interest. While other studies relied on different measures of economic performance such as ROA (Yadav et al., 2017), ROE (Aragón-Correa & A. Rubio-López, 2007; Wagner, 2005), Tobin's *q* (King & Lenox, 2002; Nakao et al., 2007), ROS (Wagner et al., 2002), and ROCE (Wagner et al., 2002), we contend that turnover is a valid proxy to sense the reactions of customers to green practices efforts because it accurately measures the immediate response of customers to such activities.

Finally, the use of Eurobarometer surveys in this study advances our knowledge of green manufacturing practices with studies based on single country contexts (Böhringer et al., 2012; Li et al., 2017; Lin et al., 2013; Nakao et al., 2007). Indeed, the value of using data collected through a survey at the European level is, first of all, that it counterbalances the overall shortage of publicly available data on green practices in companies. In addition, survey findings collected through the Flash Eurobarometer series have the advantage of reaching a wider range of respondents who might not be included otherwise.

5.2 | Contributions for practice

In addition to contributing to better scientific knowledge of the phenomenon, our study is also relevant to managers. We provide a comprehensive framework that can enable managers to design the effective management of green operations and activities to maximize their economic performance.

First, we advise companies to undertake many green manufacturing practices in their operations and processes in order to improve their economic performance. Moreover, we have shown there is an inverted U-shaped relationship between green manufacturing investments and economic performance, and we have outlined the view that there is a threshold after which the percentage of turnover expended on green manufacturing is no longer profitable for companies. In addition, we have provided evidence that selling non-green products reduces the negative effect brought about by excessive investments in green manufacturing activities. In this manner, we have provided advice on the number of green manufacturing efforts that are actually beneficial for companies.

Furthermore, we have empirically quantified the threshold point after which investments in green manufacturing become negative for firms, thereby providing indications for executives, who should not be overzealous with these practices. We have highlighted the fact this inverted U-shaped effect is mitigated if a company sells non-green products. This makes it possible to identify the optimal conditions for green investments by differentiating the products offered.

5.3 | Contributions for policymakers

In addition, our results are also of interest to policymakers who are looking for ways to face the urgent societal challenges of our day. Environmental degradation and sustainability have become some of the most important issues throughout society (Fortunati et al., 2020; Franco, 2021; Hansmann et al., 2012). This is also demonstrated by the sustainable development goals (SDGs) that have been set in this regard (Elia et al., 2020; Elia & Margherita, 2018; Secundo et al., 2020; UN, 2015). Therefore, a holistic adoption of green activities in manufacturing processes, favored by a positive reception on the part of consumers and a positive impact on economic performance and sales, may help reduce the impact of mass consumers using resources. With this aim in sight, policymakers can further expand such practices by directing green activities in a way that is beneficial for companies as well. In addition, they could also drive companies towards more sustainable innovation approaches in green manufacturing (D'Angelo & Magnusson, 2021), for example underlining the benefits of the proper recipe for green manufacturing practices in terms of improved economic performance, as evidenced by this research. In this respect, it would be beneficial channeling the fund by the framework programs like Horizon Europe, to help tackling the most urgent societal challenges and achieving the UN's SDGs.

6 | CONCLUSION

Environmental sustainability is one of the top priorities on the future global agenda, as demonstrated by the Green New Deal recently promoted by the US government (Pollin, 2019) and the European Green Deal promoted by the European Union (European Commission, 2019). Due to the global interest towards this topic, also private companies are increasing their efforts towards environmental stewardship. When it comes to the production of goods, companies may leverage green manufacturing to reach the abovementioned objective. However, it has been not clear which is the overall effect of efforts in green manufacturing practices on firm economic performance. Our results bring to light the manner in which consumers assess efforts made in green manufacturing practices, and this, in turn, has effects on company economic performance. Thus, this study provides scholars, managers, and policymakers with a comprehensive overview of the effects that green practices can have on company economic performance, and it offers a guide to properly implementing them to favor its further adoption.

We acknowledge that this study has some limitations, but these suggest interesting challenges for future research and refinement. First, this dataset focuses on European Union countries, whereas future studies could explore what happens in other regions worldwide. In addition, while our analyses regarded SMEs, future research should explore how these findings may also apply to larger companies, in order to see whether there are differences. Moreover, our dataset provides a 1-year observation set, but future studies may consider analyzing the effects of green manufacturing practices on economic performance over longer periods of time. Furthermore, although our dataset involved a wide geographical distribution of respondents and a high number of observations, responses were declared by respondents rather than measured. Therefore, future studies should investigate how the outcomes of this study may be validated by using measured values. Moreover, we grounded our study in self-determination theory, but future research could also consider other theoretical lenses to achieve a more comprehensive understanding of the impact of green practices on economic performance, like prosocial behavior, which focuses on public rather than individual well-being (Schmitt et al., 2018). In addition, as the supporting information provided by Eurobarometer does not include response rates, which limits our ability to control for non-response bias, future research could further analyze the effects of green practices in economic performance by using other primary or secondary data. This may make it possible to also include information on non-responses and to collect additional variables of interest. Further, while our study has considered the effects of green manufacturing practices on economic performance in detail, future studies could also consider how the variables employed in this research may affect brand value and company reputation. Finally, further research could deepen the role of innovation and the adoption of digital technologies in green manufacturing practices. In fact, digital technologies (e.g., Big Data, IoT, robotics, augmented and virtual reality, sensor technology, and blockchain, to name few) have been applauded to have positive effects on improving manufacturing processes and efficiency. Future researchers could explore how each of those technology could facilitate the emergence of green manufacturing practice and also affect the technology assessment conducted by consumers in terms of environmental and social benefits brought.

ACKNOWLEDGEMENTS

Open Access Funding provided by Universita Cattolica del Sacro Cuore within the CRUI-CARE Agreement.

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How to cite this article: D'Angelo, V., Cappa, F., & Peruffo, E. (2022). Green manufacturing for sustainable development: The positive effects of green activities, green investments, and non-green products on economic performance. *Business Strategy and the Environment*, 1–14. https://doi.org/10.1002/bse.3226