Received: 26 September 2022 | Revised: 30 December 2022 | Accepted: 22 January 2023

DOI: 10.1002/csr.2460

RESEARCH ARTICLE

Corporate Social Responsibility and Environmental Management

WILEY

Walking the tightrope: Circular economy breadth and firm economic performance

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Abstract

The circular economy (CE) can bring benefits but also pitfalls to the production processes, affecting a firm's economic performance. Using data from European SMEs, we empirically investigate, from the perspective of self-determination theory, the extent to which the breadth of CE activities, that is, the number of CE activities undertaken by a firm, affects a firm's economic performance. Our study theorizes and shows that there is an inverted U-shaped effect brought about by the number of CE activities on economic performance. This research advances our scientific understanding of the CE and provides managers with suggestions on how to maximize the benefits generated by the CE in terms of economic performance by implementing the right amount of CE activities.

KEYWORDS
3R, attention-based view, circular economy, performance, self-determination theory, turnover

1 | INTRODUCTION

Pressure from stakeholders to reduce the negative impact of economic activities on society and the environment has grown as citizens are increasingly aware of the "grand challenges"—that is, pressing environmental and social problems—that now deeply affect urban areas and society in general (Berrone et al., 2013; Cappa, Rosso, Giustiniano, & Porfiri, 2020; Centobelli, Cerchione, Chiaroni, et al., 2020). For this reason, a growing number of firms are moving toward the adoption of circular economy (CE) practices, as part of the increasing inclusion of environmentally-oriented efforts in their corporate strategy (Hourneaux et al., 2014; Morea et al., 2022).

The CE can be defined as "an industrial system that is restorative or regenerative by intention and design. It replaces the "end-of-life" concept with restoration, shifts toward the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models" (Ellen MacArthur Foundation, 2012, p. 7). Unlike the traditional linear model based on "take-make-waste," in the CE industrial system the waste generated by production and consumption processes becomes input, generating a closed loop that mimics the living systems of the environment. For this reason, the CE concept is considered to be a solution that harmonizes ambitions regarding economic growth and environmental protection because it is based on neutralizing waste in the production and sale of goods (Ghisellini et al., 2016).

It has been also shown that the CE is beneficial for firms in many ways. The CE contributes to company value creation (Centobelli, Cerchione, Chiaroni, et al., 2020; Despeisse et al., 2017; Ünal et al., 2019), improves processes and production (Centobelli et al., 2021; Lieder & Rashid, 2016), and triggers resource efficiency (Geissdoerfer et al., 2018; Shashi et al., 2019). However, the adoption of CE practices is not exempt from pitfalls. Previous studies have found that recycling activities require great effort by the entire firm (Ghisellini et al., 2018), that all CE activities in general require a considerable amount of upfront investment (Y. Liu & Bai, 2014), and that the CE activities need to be aligned with the companies' (Barnabè & Nazir, 2022) strategic orientation. In addition, the established

processes and routines of companies may be challenged by the new CE principles (Ghisellini & Ulgiati, 2020; Navarro et al., 2020), and the entire supply chain may even be restructured as a consequence of the CE practices bringing to additional efforts for organizations (Lieder & Rashid, 2016). In addition, some sectors (e.g., the constructions sector) might be even more resistant to the adoption of CE practices due to their structural characteristics (Ghisellini et al., 2018). Nonetheless, whereas the benefits of CE practices have attracted the majority of scholarly and managerial interest, the drawbacks associated with CE practices have mostly been overlooked. Therefore, there is a need for a more comprehensive understanding of the effects CE activities can have, including both advantages and disadvantages.

While previous studies have used different metrics to assess the benefits of the CE for company performance—such as company productivity (Moric et al., 2020), or a firm's market value (Aboulamer, 2018), in line with recent research on this topic (Demirel & Danisman, 2019) we contend that it is needed to focus on economic performance to provide companies an economic assessments of the effects of CE. We contend that central to the adoption of CE activities is their effect on customer perceptions of a firm. In fact, as environmental awareness has risen among consumers (Dijksterhuis et al., 2005), firms that make efforts to comply with these expectations are rewarded with an increase in sales (Confente et al., 2020). On the other hand, an excess of ongoing efforts devoted to the CE counters the impact on economic performance because customers feel the company is focusing too much on converting production to CE standards and therefore neglecting other important aspects such as product quality, innovativeness, and customer care. From an attention-based view, excessive efforts in certain strategic activities undermine other crucial aspects (Franco et al., 2020; Ocasio & Joseph, 2005). Given the contrasting effects produced by the CE, it is not clear to what extent it can be beneficial for firms. Therefore, in this study we have addressed the following research question: does the breadth of circular economy activities have an inverted U-shaped effect on firm economic performance?

We adopt self-determination theory (SDT) (Deci & Ryan, 2012; Ryan & Deci, 2000), which explains consumers' actions based on what drives them to be satisfied—in this case resolving environmental issues—as grounding theory to uncover the effects of the CE. Borrowed from psychology, self-determination theory argues that people act to fulfill their needs of innate psychological nourishment that are essential for ongoing psychological growth, integrity, and well-being, thus representing a valid lens to observe the consumers' attitude toward firms' approach to CE. Thus, in line with previous studies that focused on responsible behavior in individuals (Cappa et al., 2019; Cappa, Rosso, Giustiniano, & Porfiri, 2020; Koo & Chung, 2014), we rely on self-determination theory to study how consumers are influenced by a sense of satisfaction in contributing to environmental aims when buying products.

We contend and provide empirical evidence that there are both benefits and drawbacks for a firm's economic performance brought about CE activities, resulting in a curvilinear relationship. In particular, we demonstrate that there is a threshold after which any additional CE activity undertaken reduces the positive effect for firms because consumers may feel that too many efforts are being devoted to this focus, to the detriment of other objectives. We conducted the analysis on data from Eurostat of 10,618 SMEs from 28 European countries. The choice to focus on SMEs is due to the relevance of the context, as demonstrated by previous studies (Ardito et al., 2021), because SMEs are companies characterized by structural barriers which might hinder the implementation if CE activities, like lack of human and financial resources, the costs of meeting the regulations and to align with normative procedures (García-Quevedo et al., 2020). Therefore, the analysis of the effects brought about by CE for this type of firms, which have a key role in the economic scenario especially in Europe (Fasano & Cappa, 2022), might highlight insights able to further nurture its application in this context. While the choice of the context of European Union to is due to the overtime engagement of European Union in promoting measures to advance the adoption of CE among small and medium enterprises (Mazur-Wierzbicka, 2021).

Examples are the 2015 Circular Economy Action Plan to promote Europe's transition toward a CE, or the more recent EU funding programs supporting the transition to a CE like the Horizon Europe, New cohesion policy, and LIFE. Such policies have further pushed the interest and adoption of CE in Europe as evidenced by a recent report (European Commission, 2020).

Using an ordinal logistic regression to conduct our analysis, we found that there is an inverted U-shaped effect of CE activities on economic performance: undertaking a low number of CE activities has a positive effect on a firm's economic performance, but this effect is reduced if the number of CE actions undertaken exceeds a specific threshold, after which it negatively affects the firm's other duties and efforts.

The contributions of the paper are manifold. First, we reconcile mixed findings and views on the impact of the CE on a firm's performance, highlighting that the CE triggers both advantages and pitfalls, resulting in an inverted U-shaped effect. Second, we highlight the position that SDT is a valid lens to use when examining CE practices, as it allows to consider both costs and benefits when evaluating every aspect involved in the CE. Third, we advance the work of previous studies that used other proxies of performance by focusing on economic performance. Finally, we also provide evidence for managers and policymakers regarding the effects on company performance of an excessive CE focus, in order to stimulate countermeasures to curb this effect.

The rest of the article is structured as follows: in Section 2, we outline the theoretical background and hypothesis development of our study; Section 3 lays out the data and methodology employed; Section 4 describes the results of the analysis; and Section 5 provides findings and discussion, as well as managerial and policy implications and directions for future research.

2 | BACKGROUND AND HYPOTHESIS

2.1 | The emergence of circular economy

The CE model is inspired by environmental economics and industrial ecology (Ehrenfeld & Gertler, 1997), and it encompasses the idea of

"closing-the-loop" in the production process, creating a restorative system where waste materials can have a "new life" (Del Vecchio et al., 2020; Ghisellini et al., 2016). Scholars agree on defining the CE as "an economic system that replaces the 'end-of-life' concept with reducing, alternatively reusing, recycling and recovering materials in production/distribution and consumption processes" (Kirchherr et al., 2017, p. 229), which not only aims to regenerate natural systems but also include the use of renewable energy sources, as well as seeking to reduce waste and pollution in order to build economic, natural, and social capital (Ellen MacArthur Foundation, 2019). These goals need to be pursued through action that achieves "restoration [of resources], shifts towards the use of renewable energy, eliminates the use of toxic chemicals, which impair reuse, and aims for the elimination of waste through the superior design of materials, products, systems, and, within this, business models" (Ellen MacArthur Foundation, 2012, p. 7).

The growing concerns of governments and businesses regarding the intensive consumption of finite resources is leading to the choice of the CE paradigm as a solution to address resource scarcity and waste generation while sustaining economic growth (Geissdoerfer et al., 2018; Ghisellini et al., 2016; Morea et al., 2021). In fact, as many natural resources are finite, the CE constitutes a solution that creates new methods for harnessing and using resources (Lieder & Rashid, 2016). Because of the growing focus on "grand challenges" worldwide (Cappa, Rosso, Giustiniano, & Porfiri, 2020; Foray et al., 2012), the CE can be an effective means to tackle such issues. Specifically, "grand challenges" are open-ended global objectives, such as secure, clean and efficient energy production (Foray et al., 2012). To achieve these aims, different technological innovations, organizational solutions and policymaking decisions can be explored at a global level (Ardito et al., 2019; Cappa, Rosso, Giustiniano, & Porfiri, 2020; Fagerberg, 2018; Kuhlmann & Rip, 2018).

The traditional definition of CE encompasses the idea of transforming any waste material from a production or a consumption process into a fuel to nurture a new production or consumption cycle. The main actions through which the CE is created are the so-called "3R" principles—*reduce*, *reuse*, and *recycle* (L. Liu et al., 2017). *The goal of the reduce principle* is to minimize the overall materials consumption, *energy* and waste generated in the system by increasing efficiency in both production and consumption through an optimal use of resources (for instance, by improving technologies, simplifying packaging, and using more power-efficient appliances) (Ranta et al., 2018). The *reuse* principle holds that using products and components again requires fewer resources and less energy and labor than producing new ones from virgin materials or even recycling products (Castellani et al., 2015). The *recycle* principle refers to "any recovery operation by which waste materials are reprocessed into products, materials, or substances whether for the original or other purposes" (European Council, 2008).

2.2 | The impact of circular economy on economic performance

Besides the overall benefits regarding natural resources and the environment, the economic impact of the CE is another important driver that may further encourage its adoption within firms' activities. Although previous literature has largely explored and agree on the overall benefits of the CE on society and environment (Ghisellini et al., 2016; Lieder & Rashid, 2016), less is known about the effects of CE on the companies' economic performance.

To understand the impact of CE on firms, we should consider the effects of CE activities for customers, as these are also reflected in a firm's revenue. We argue that SDT (Deci & Ryan, 2012; Ryan & Deci, 2000) should be applied for a complete understanding of the effect of CE activities. Indeed, the flourishing interest in the environment and resources (Ba et al., 2013; Buysse & Verbeke, 2003; Hussainey & Salama, 2010) mirrors the awareness of these issues among stakeholders and, in particular, among consumers, who reward companies that adopt "environmentally-oriented" practices being in more tight connection with them (Branco & Rodrigues, 2006; Lim, 2017). Moreover, as the paradigm of green consumerism takes root (Prothero, 1990), consumer willingness to buy "green" and "green manufactured" products is increasing (Grimmer & Woolley, 2014).

The role of consumers in CE business models has been previously explored by the literature, in particular in terms of their role in actively contributing to the reverse logistics, enabling product at their end of life to return to the producers, those contributing to closing the loop (Parajuly et al., 2020), and in terms of how end-user engagement enables the flourishing of a market of CE related products, such as those with long lifespans (high quality, adjustable, repairable, etc.) (Shevchenko et al., 2023; Wang et al., 2020). In these respects, the attitude of consumers toward remanufactured products is one of the key drivers of the companies' decision to engage in CE activities. For these reasons, companies are striving to align themselves with the expectations of consumers that want companies to take a stand on social and ethical issues (Ambec & Lanoie, 2008; Buysse & Verbeke, 2003). Furthermore, since the adoption of the CE may require an ad-hoc reverse logistical infrastructure (Dey et al., 2019; Mangla et al., 2018)—for example, if the firm is in charge of collecting back waste materials from consumers—this would result in a longer-term relationship between the customer and the firm (Centobelli, Cerchione, & Esposito, 2020), followed by stable growth of company cash flows (Aboulamer, 2018). Therefore, we hypothesize the breadth of the CE will have a positive effect on a firm's revenues.

However, the implementation of CE activities may also bring drawbacks as structural and organizational changes are required (Ünal et al., 2019). In particular, it requires energy efficiency-driven practices to reduce emissions (Stahel, 2013); a shift toward the use of environmentally friendly materials which are natural, recyclable, durable, and easy to separate (Bocken et al., 2016); redesigning the value chain and the key players involved, if they are not aligned with CE practices (Lewandowski, 2016); and implementing a reverse-flow for collecting product materials from customers when the product is no longer in use, and putting these back into the cycle (Ormazabal et al., 2018). All of these actions require massive operations and ecosystem transformation (Ghisetti & Montresor, 2019; Parida et al., 2019), which might in turn absorb significant company efforts (Aranda-Usón et al., 2019). Although consumers approve of firms engaging in the CE, an overload of CE activities could

have a negative side effect if consumers feel such activities could distract firms from their main strategy. Indeed, according to the attention-based view (Ocasio & Joseph, 2005), having multiple focuses, rather than just one, has indeed been shown to be harmful for some companies (Franco et al., 2020; Ocasio & Joseph, 2005). Consumers may believe that a firm's considerable investments in implementing many CE activities could have a detrimental effect on product quality and performance, for a twofold reason. First of all, the change in the operational structure may affect the manufacturing process and thus product performance (Gharfalkar et al., 2018; Yang et al., 2012), posing additional challenges caused by the implementation of new practices (Ünal et al., 2019) and new operations, routines and assets (Tunn et al., 2019), thus absorbing resources which are taken away from other uses; secondly, firms commit most of their investments in CE activities to meet customer expectations, marginalizing other investments directed, for example, toward improving product quality or processes (Chuang & Yang, 2014; Sagnak & Kazancoglu, 2016; Yang et al., 2012). In addition to this, previous studies have found that CE practices may encounter some cultural barriers in the eyes of customers, which could have bad attitude toward repaired or reconditioned products (Laitala et al., 2021).

While previous studies have considered CE as able to bring either benefits or drawbacks, we contend that they need to be jointly considered, through a linear and a quadratic effect, to comprehensively assess the impact of CE. In particular, we focused on the number of CE practices adopted, that is, CE breadth, to highlight the overall advantages and disadvantages brought by CE to a firm's economic performance. In particular, a limited number of activities benefit a firm's economic performance because consumers see the firm's environmental efforts as positive and therefore reward it by choosing the firm over its competitors, resulting in an increase in sales. On the other hand, many CE activities imply that marginal drawbacks lessen the benefits if these additional efforts by the firm are not recognized by consumers, when they perceive a firm's efforts as being more focused on recycling, materials, resource efficiency and green logistics than on their core business.

Hence, there are rewards for firms that make some effort rather than doing nothing regarding the CE, but then consumers might punish an overload of CE activities because they feel that other company activities and aims, like quality and innovation, are being left behind. This leads us to posit the following hypothesis:

There is an inverted U-shaped effect brought about by the breadth of circular economy activities undertaken by companies on their economic performance.

The theoretical model tested in this study is also represented in Figure 1.

3 | DATA AND METHODS

To test the above-mentioned hypothesis, we used data on small and medium-sized enterprises (SMEs) retrieved from Eurostat database. In particular, data have been collected by the European Commission Directorate - General Environment through a survey ("Flash Eurobarometer 441: European SMEs and the Circular Economy"), conducted across 28 European countries, covering 10,618 SMEs with fewer than 250 employees. The survey is part of the Flash Eurobarometer Series, which are ad hoc thematic telephone interviews conducted at the request of any service of the European Commission and has been already evidenced to be a reliable source for conducting research (Cainelli et al., 2020). A total of 10,618 top-level executives were interviewed over the phone in September 2017, based on 2016 as the year of reference. Table 1 reports the detailed description of the variables coming from the survey employed in the analysis, which comprise categorical, discrete dummy and continuous variables. The characteristics of the sampled firms are shown in Table 2.

Given the ordered, categorical nature of the variables, we use an ordinal logistic regression to test our hypothesis. Ordinal logistic regression is used to model the relationship between an ordinal response variable and one or more explanatory variables, where the

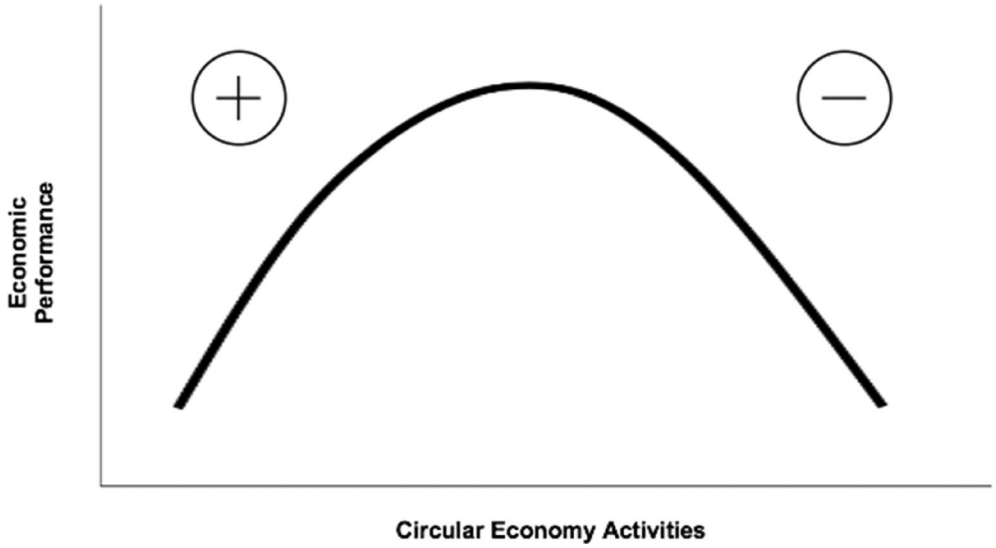

FIGURE 1 The theoretical model tested in this study: The inverted U-shaped effect brought about by "Circular Economy Activities" on "Economic Performance."

TABLE 1 Description of variables.

Variable	Type	Description
Turnover increase	Categorical	Variation in turnover compared to the previous year
Breadth of CE activities	Discrete	Number of circular economy activities undertaken
Nace 1	Dummy	Mining and quarrying
Nace2	Dummy	Manufacturing
Nace3	Dummy	Electricity, gas, steam, and air conditioning
Nace4	Dummy	Water supply, sewerage, waste management
Nace5	Dummy	Construction
Nace6	Dummy	Wholesale and retail trade
Nace7	Dummy	Transportation and storage
Nace8	Dummy	Accommodation and food services
Nace9	Dummy	Information and communications
Size	Discrete	Number of employees
Age	Categorical	Age of company
R&D investment (% of turnover)	Categorical	Average turnover invested in R&D activities
Wex	Continue	Weight extrapolated population (Enterprises)

TABLE 2 Sample firms' characteristics and distribution.

Characteristic	Category	Percentage
Firm age	Established before 1 January 2010	83.10
	Established between 1 January 2010 and 1 January 2015	14.79
	Established after 1 January 2015	2.11
Firm size	1 to 9 employees	62.98
	10 to 49 employees	23.31
	50 to 250 employees	13.71
Industry	Manufacturing	13.64
	Retail	34.16
	Services	38.90
	Extraction, energy and construction	13.31

ordinal variable is a categorical variable for which there is a clear ordering of the category levels (Agresti, 2006).

In the following subsections, we detail how we built the dependent, independent and control variables in our study.

3.1 | Dependent variable

The dependent variable is measured as the variation of total turnover (*Turnover Increase*) compared to the previous year, as a proxy for economic performance. As a matter of fact, turnover is an effective measure for economic performance and company growth because it provides information on earnings from business activities, which is useful when assessing how well a company has performed (Wagenhofer, 2014). *Turnover Increase* is a categorically ordered variable defined by seven possible outcomes: (1) decreased by more than 10%; (2) decreased by 5% to 10%; (3) decreased by 2% to 5%; (4) remaining approximately the same; (5) increased by 2% to 5%; (6) increased by 5% to 10%; or (7) increased by more than 10%. The average value is 4.218 with a standard deviation 1.659.

3.2 | Independent variable

Our independent variable (*Breadth of CE Activities*) was created as the sum of single CE activities and it can assume values between 0 and 5. The possible CE activities undertaken by firms are the following: (i) re-planning water usage to minimize use and maximize reuse; (ii) using renewable energy; (iii) re-planning energy usage to minimize consumption; (iv) minimizing waste by recycling or reusing waste or selling it to another company, and (v) redesigning products and services to minimize the use of materials or using recycled materials. As each activity is coded dichotomously in the database, it assumes the value of 1 if the firm has either implemented the CE activity or is in the process of implementing it, and 0 otherwise. Our variable thus allows us to measure the breadth of CE actions undertaken by each firm. The average value is 1.693 with a standard deviation of 1.435, implying that companies on average undertake 2 or less activities. The quadratic term (*Breadth of CE Activities Squared*) was also added to test the U-shaped relationship.

3.3 | Control variables

Several control variables have been considered. To account for the different impact of the CE on different sectors, industry dummies were included. These industrial sectors (mining and quarrying; manufacturing; electricity, gas, steam, and air conditioning; water supply, sewerage, and waste management; construction; wholesale and retail trade; accommodation and food services; and information and communications) with *Nace* dummies were included. Then we considered the dimension of the firm with *size*, measured as the number of employees, and the company's lifespan with *age*, a categorically ordered variable defined by three outcomes (before 1 January 2010; between 1 January 2010 and 1 January 2015; and after 1 January 2015). The firm's R&D expenditure (*R&D Investment*) was also included, measured as the previous year's percentage of company revenue invested, a categorically ordered variable which assumes values between 1 and 5 (respectively (1) less than 5%; (2) from 5% to 9.9%; (3) from 10% to 14.9%; (4) from 15% to 19.9%; (5) 20% or more). The average value is 1.73 with a standard deviation of 1.49, showing on average a limited percentage of revenues invested in R&D. The post stratification sample weighting factor (*Wex*—Weight Extrapolated

TABLE 3 Descriptive statistics and correlations.

Variable	Mean	SD	Min	Max	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1. Turnover increase	4.218	1.659	1	7	-														
2. Breadth of CE activities	1.693	1.435	0	5	0.0275	-													
3. Nace1	0.002	0.053	0	1	−0.0031	0.0142	-												
4. Nace2	0.1363	0.343	0	1	−0.0010	0.0879	−0.0214	-											
5. Nace3	0.0057	0.075	0	1	−0.0091	0.0457	−0.0040	−0.0298	-										
6. Nace4	0.0094	0.0965	0	1	−0.0073	0.0633	−0.0050	−0.0379	−0.0070	-									
7. Nace5	0.1150	0.3191	0	1	0.0006	0.0096	−0.0194	−0.1455	−0.0269	−0.0343	-								
8. Nace6	0.3415	0.4742	0	1	0.0004	−0.0297	−0.0386	−0.2893	−0.0536	−0.0682	−0.2619	-							
9. Nace7	0.0617	0.2407	0	1	0.0056	−0.0756	−0.0139	−0.1044	−0.0193	−0.0246	−0.0945	−0.1878	-						
10. Nace8	0.0712	0.2573	0	1	0.0020	0.1012	−0.0145	−0.1090	−0.0202	−0.0257	−0.0987	−0.1962	−0.0708	-					
11. Nace9	0.0454	0.2083	0	1	−0.0082	−0.0746	−0.0115	−0.0864	−0.0160	−0.0204	−0.0782	−0.1555	−0.0561	−0.0586	-				
12. Size	20.682	38.48	0	250	0.0064	0.1612	0.0108	0.1536	0.0172	0.0653	−0.0172	−0.1092	0.0199	−0.0089	−0.0027	-			
13. Age	1.19	0.457	1	3	−0.0335	−0.0729	−0.0094	−0.0598	0.0134	−0.0175	−0.0023	−0.0262	0.0097	0.0585	0.0292	−0.1223	-		
14. R&D Investment	1.73	1.49	1	5	−0.0205	0.1313	−0.0031	0.0125	0.0039	0.0191	−0.0295	−0.0669	−0.0243	0.0003	0.0875	0.0537	0.0081	-	
15. Wex	2023.95	3000.3	2.3	19,534	0.0809	−0.0309	−0.0074	−0.0768	−0.0113	−0.0232	0.0500	0.0418	−0.0530	0.0389	−0.0008	−0.2640	0.0528	−0.0089	-

Population) is included to adjust each national sample in proportion to its share in the total population of the European Union aged 15 and over (based on population figures published by EUROSTAT in the Regional Statistics Yearbook).

Details of the above-mentioned variables are reported in Table 1, including the variables name, the type and a short description of the variables. Descriptive statistics are reported in Table 3.

4 | RESULTS

The correlations for all the variables included in the study are reported in Table 3, together with the descriptive statistics. Correlation values are all below 0.7, thus demonstrating the absence of multicollinearity concerns (Cohen et al., 2003).

Given the ordered, categorical nature of the dependent variable, we estimated an ordinal logistic model with robust standard error. The results of the ordinal logistic regression are reported in Table 4, including first only control variables (Model 1), then adding the linear effect of CE breadth (Model 2) and finally running the full model including the quadratic effect (Model 3). The parameter estimates of an ordinal logistic regression represent the natural logarithm of the odds ratio of stepping to a higher category of the dependent variable for each unit increase of the independent variable. Formally, an ordinal logistic regression model can be expressed by the following equation:

$$logit(P(Y \le j)) = \beta_{j0} + \beta_j x_1 + \cdots + \beta_p x_p,$$

where Y represents an ordinal outcome with J categories. Therefore, our model can be expressed as follows:

$$\begin{aligned} logit = {} & \beta_{j0} + \beta_j Breadth\ of\ CE + \beta_j Breadth\ of\ CEsquared_i + \beta_j Nace1 \\ & + \beta_j Nace2 + \beta_j Nace3 + \beta_j Nace4 + \beta_j Nace5 + \beta_j Nace6 + \beta_j Nace7 \\ & + \beta_j Nace8 + \beta_j Nace9 + \beta_j Size + \beta_j Age + \beta_j R\&D\ln c \\ = {} & vestment + \beta_j Wex. \end{aligned}$$

In Model 2 the independent variable *Breadth of CE Activities* has a positive and significant effect on the dependent variable *Turnover Increase* ($\beta = 0.166$, $p < 0.01$). This means that for each additional circular economy activity, the probability of *Turnover Increase* to step to the higher category is equal to 16.6% while the other variables in the model are held constant.

In Model 3, we have a significant and negative effect for the quadratic term *Breadth of CE Activities Squared* ($\beta = -0.026$, $p < 0.01$) and a positive linear effect for *Breadth of CE Activities* ($\beta = 0.166$, $p < 0.01$), highlighting the presence of an inverted U-shaped effect on *Turnover Increase*. This result provides support for our hypothesis. The value of the pseudo R^2 recorded in our model is in line with the value found in previous studies that have used ordinal logistic regression (Cheah et al., 2011; D'Angelo et al., 2022). In addition, the value of pseudo R^2 increases when variables are added throughout our model, thus showing the improvements brought about by the full model.

In order to have a more in depth understanding on the effect of the breadth of CE activities on each interval of *Turnover Increase*, we analyze the marginal effect of the independent variable *Breadth of CE Activities*. To analyze the marginal effect, we compute the margins of the independent variable *Breadth of CE Activities*, based on the estimates of Model 3. The marginal effect represents the average change in probability to step up to the following level of ordinal category of dependent variable, in this case *Turnover Increase*, when the dependent variable *Breadth of CE Activities* increases by one unit, that is,

TABLE 4 Ordinal logistic regression with "Turnover Increase" as dependent variable.

	Model 1	s.e.	Model 2	s.e.	Model 3	s.e.
Breadth of CE activities			0.056***	0.015	0.166***	0.044
Breadth of CE activities squared					−0.026***	0.010
Nace1	−0.494*	0.279	−0.521*	0.287	−0.522*	0.289
Nace2	0.029	0.072	0.015	0.077	0.008	0.077
Nace3	−0.376	0.244	−0.378	0.265	−0.354	0.263
Nace4	−0.209	0.194	−0.314	0.212	−0.303	0.212
Nace5	−0.066	0.074	−0.059	0.080	−0.060	0.080
Nace6	−0.063	0.056	−0.048	0.060	−0.054	0.060
Nace7	−0.042	0.090	−0.005	0.095	0.000	0.095
Nace8	−0.062	0.087	−0.051	0.096	−0.049	0.096
Nace9	−0.060	0.102	−0.023	0.112	−0.022	0.112
Size	0.000*	0.000	0.001*	0.000	0.001*	0.000
Age	−0.160***	0.039	−0.163***	0.045	−0.163***	0.045
R&D investment	−0.118***	0.010	−0.115***	0.012	−0.114***	0.012
Wex	0.000	7.90 e-06	0.000***	8.72 e-06	0.000***	8.71 e-06
Pseudo−R^2	0.0067		0.0070		0.0073	

Note: Number of observations = 9488.
*$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.

TABLE 5 Average marginal effect of "Breadth of CE Activities" (BCEA in this table) on "Turnover Increase."

Turnover increase	BCEA = 1	BCEA = 2	BCEA = 3	BCEA = 4	BCEA = 5	BCEA = 6	BCEA = 7	BCEA = 8	BCEA = 9
1	0.0311*** (0.002)	0.026*** (0.001)	0.022*** (0.001)	0.019*** (0.002)	0.016*** (0.002)	0.013*** (0.002)	0.011*** (0.002)	0.009*** (0.002)	0.008*** (0.002)
2	0.029*** (0.002)	0.025*** (0.001)	0.021*** (0.001)	0.018*** (0.002)	0.016*** (0.002)	0.013*** (0.002)	0.011*** (0.002)	0.009*** (0.002)	0.008*** (0.002)
3	0.027*** (0.0019	0.023*** (0.001)	0.020*** (0.001)	0.017*** (0.001)	0.015*** (0.002)	0.013*** (0.002)	0.011*** (0.002)	0.009*** (0.002)	0.008*** (0.002)
4	0.107*** (0.004)	0.095*** (0.003)	0.084*** (0.004)	0.073*** (0.006)	0.064*** (0.007)	0.056*** (0.009)	0.048*** (0.009)	0.042*** (0.010)	0.036*** (0.010)
5	0.014*** (0.001)	0.013*** (0.001)	0.011*** (0.001)	0.010*** (0.001)	0.009*** (0.009)	0.008*** (0.001)	0.007*** (0.001)	0.006*** (0.001)	0.005** (0.001)
6	0.014*** (0.001)	0.013*** (0.001)	0.012*** (0.001)	0.010*** (0.001)	0.009*** (0.001)	0.008*** (0.001)	0.007*** (0.001)	0.006*** (0.001)	0.005*** (0.001)
7	0.023*** (0.001)	0.021*** (0.001)	0.019*** (0.001)	0.017*** (0.001)	0.015*** (0.001)	0.013*** (0.002)	0.012*** (0.002)	0.010*** (0.002)	0.009*** (0.002)

Note: Robust standard errors in parentheses.
*$p < 0.10$; **$p < 0.05$; ***$p < 0.01$.

TABLE 6 VIF test for collinearity.

Variable	VIF	1/VIF
Breadth of circular economy activities	1.08	0.922975
Nace1	1.01	0.988647
Nace2	1.47	0.681541
Nace3	1.02	0.976515
Nace4	1.04	0.959594
Nace5	1.39	0.721996
Nace6	1.75	0.570383
Nace7	1.23	0.814347
Nace8	1.26	0.794205
Nace9	1.17	0.857413
Size	1.14	0.875567
Age	1.03	0.973910
R&D investment	1.04	0.965504
Wex	1.08	0.923178

when additional CE activities are undertaken. The results of the computation of the marginal effect are reported in Table 5. The margins allow to understand how the probability to be in one of each level of turnover increase is affected by the breadth of CE activities, and, in other words, the effect brought by each additional activity. The marginal effects of additional activities show a decreasing trend. There is a stronger effect on the likelihood to improve the turnover for the outcome of the dependent variable regarding the outcomes (1) "decreased by more than 10%"; (2) "decreased by 5% to 10%"; (3) "decreased by 2% to 5%"; in other words, the beneficial effect of circular economy activities is stronger for reducing the turnover decrease, although the effects hold for each level of *Turnover Increase*. Overall, these results confirm our hypothesis and our findings regarding an overall positive benefit on economic performance.

An additional assessment of the model has been conducted to ensure the robustness. In order to avoid social desirability bias the questionnaire granted anonymity (Todaro et al., 2019). Also, most of the responses were designed with a categorical scale, thus providing respondent with a range of interval to choose from which might be easier to answer and to finish the questionnaire remaining focused. Furthermore, we ran the variable inflation factors (VIF) test to further check for multicollinearity. The VIF values, shown in Table 6, are no greater than 1.0, and therefore below the recommended maximum accepted value of 10 (Cappa & Pinelli, 2021; Fasano & Deloof, 2021; Franco et al., 2020; La Rocca et al., 2022), providing further evidence for the absence of multicollinearity (Lorenz et al., 1986).

In addition, we also conducted the robustness test suggested by Haans et al. (2016) to check the curvilinear relationship between our variables, in line with previous studies which have employed a similar approach (Gambardella et al., 2020). We followed the Lind and Mehlum (2010) methodology and we ran the U test for the U-shaped curves. Table 7 shows the results of the U test. The slope of the lower bound is positive and significant, while the slope of the upper bound

is negative and significant, and the extreme point (i.e., the negative peak) is located within the data range, thus validating our results and confirming the inverted U-shaped effect brought about by the breadth of CE activities on economic performance, and thus supporting our hypothesis.

5 | DISCUSSION

In this study, we demonstrated that as the number of CE activities undertaken increases, the marginal effects on economic performance diminish, eventually turning into an overall negative influence. In other words, the number of CE activities has a positive effect on a firm's economic performance, but the effect is reduced if the number of activities undertaken increases, and if it exceeds a certain threshold the effects turns to be negative, showing an overall inverted U-shaped effect. We ascribe our results to SDT, according to which consumers react positively to a firm's investments to fulfill their increasing environmental concerns. However, massive investments can be perceived by customers as distracting if firms overlook other activities like product quality enhancement, product innovation and customer care, resulting in less performative outcomes. Therefore, they require effort on the part of firms. Indeed, from an attention-based view, a company must not be involved in too many activities, or else it will lose its main strategic focus (Ocasio & Joseph, 2005). The results highlight the role of customers as key actors within the CE business models, not only in terms of how actively they are involved in recycling and reusing, but also for their role in assessing which company is adequately adopting CE practices and which not. Further, the customers' assessment results in purchasing or not the company's product, therefore affecting turnover. This should encourage companies in taking account of the customers' assessment when planning to shift toward CE models.

Figure 2 graphically represents the inverted U-shaped effect of CE activities on the economic performance of firms. The graph shows that the marginal effect on economic performance of each additional CE activity is positive until the peak of the curve, located where the breadth of CE activities is between 3 and 4, as also shown in Table 5, but it becomes negative after this turning point. This means that the firms located on the left side of the curve registered increased performance for each additional CE activity undertaken, whereas the firms located after the turning point, that is, on the right side of the curve registered a decreasing benefit in terms of economic performance for each additional CE activity undertaken, while still maintaining the overall positive effect. After the turning point, the drawbacks of CE activities start to affect the linearly increasing benefits for economic

TABLE 7 U test for U-shaped relationship.

Group	Lower bound	Upper bound
Interval	0	5
Slope	0.144*** (2.93)	−0.09* (−1.35)
Overall test	1.36	0.0876
Extreme point	3.052	

*p < 0.10; **p < 0.05; ***p < 0.01.

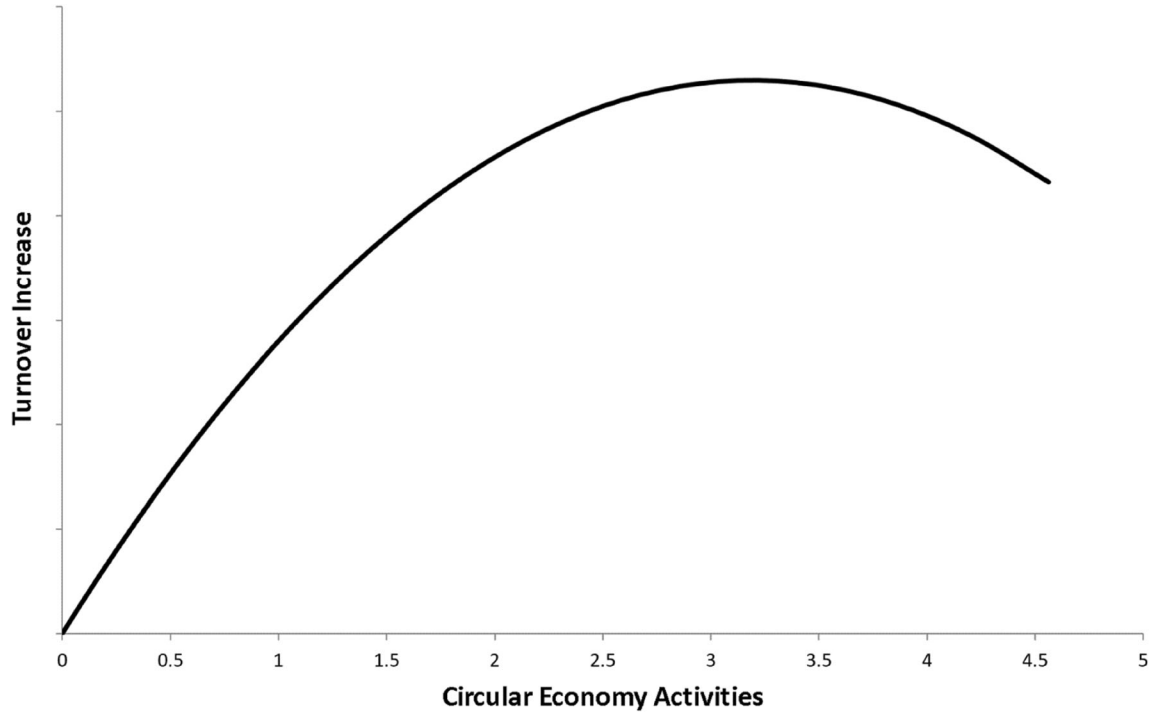

FIGURE 2 The inverted U-shaped effect of "Breadth of Circular Economy Activities" on "Turnover Increase" (as a proxy of "Economic Performance").

performance, and the marginal effect produced by the fourth and the fifth additional CE activities have a less beneficial effect on economic performance.

The outcomes of this study reconcile previous findings on the impact brought about by CE actions, since some scholars have stressed the positive effects while few have focused on the pitfalls. Our study underscores that both benefits and drawbacks exist and should be carefully considered as we have highlighted the existence of a threshold at which additional CE activities switch to being detrimental for company performance. Given the importance of the CE in addressing environmental distress and responding to the "grand challenges" that affect our times, it is important for firms to understand how to achieve the optimal balance in the breadth of their CE activities. This finding can lead managers to be more favorable toward CE activities, while still maintaining the right balance that can both please customers and enhance company turnover.

In the following subsections, we dissect the contributions of this research for scholars, managers and policymakers.

5.1 | Implications for theory

The contributions of this study are manifold. First, our study provides a comprehensive picture of the effects of the CE in the economic performance of firms, reconciling previous results that considered only positive or negative effects (Centobelli, Cerchione, Chiaroni, et al., 2020; Ghisellini et al., 2018; Iraldo et al., 2011; Lieder & Rashid, 2016; Y. Liu & Bai, 2014; Navarro et al., 2020). In particular, we disentangle the effect of CE activities into a linear and a quadratic one, recognizing that both benefits and drawbacks are present. On the one hand, they increase revenue as a result of positive firm perception by customers when facing the pressing grand challenges of this era. On the other hand, an overload of activities undertaken has a disturbing effect on consumer impressions because they believe that massive CE actions require significant investments that can hinder a firm's other strategic activities and mitigate the effect of CE breadth on the firm's economic performance.

Second, we add to the CE literature by showing that SDT (Deci & Ryan, 2012; Ryan & Deci, 2000) is a valid theoretical lens to observe the economic impact of CE activities in firms. In fact, if we wish to grasp the overall effect of the CE adopting the perspective of the consumer could be useful, and SDT allows to explain how the connection with the firm, proxied by turnover increase, may be boosted or hindered by different amount of CE activities. In so doing we also contribute to the understanding of CE from the perspective of consumer behavior. A transition toward CE models may leverage non-rational intrinsic motivations (Adıgüzel & Donato, 2021), but rational reasons regarding the fear of an excessive effort toward environmental attention should also be considered.

Third, while previous studies focused on the impact that the CE has on other dimensions of company performance—such as stakeholder engagement (Jakhar et al., 2019; Zhang & Zhu, 2019), sustainability performance (Gupta et al., 2021), environmentally-oriented supply chain cooperation (ESCC) (Zhu et al., 2010), market equity value (Aboulamer, 2018), manufacturing performance (Mishra et al., 2019), reduced material use per unit of output (Cainelli et al., 2020), and carbon footprint (Elia et al., 2017)—we focus on the impact of the CE on turnover, in line with recent research (Demirel & Danisman, 2019), through which it thus possible to grasp the overall effects of CE for firms. With respect to recent research that has focused on CE and economic performance (Demirel & Danisman, 2019), which have provided an empirical exploration of the topic, we have theorized and empirically tested that for a comprehensive understanding of the impact of CE activities it is crucial to focus on the overall number of CE activities, that is, CE breadth, rather than the single effects of each activity, and to consider the quadratic effect in addition to the linear one.

5.2 | Implications for managers

In addition to contributing to better scientific knowledge of the phenomenon, our study is also relevant for managers. Specifically, we provide some initial suggestions on the best level of effort to make, in terms of the number of CE activities to be undertaken. In order to maximize the positive effects on economic performance, increasing the breadth of CE activities is beneficial in terms of producing an increase in revenue, but too many efforts surrounding the CE become less beneficial. Considering the recent growing interest in the CE, it may be extremely useful for managers to know that a threshold exists. Therefore, we invite managers who wants to adopt CE practices to carefully design a proper adoption strategy and consider how CE activities could potentially affect economic performance. In addition, once identified the right level of CE activities to undertake, managers might carefully inform customers about such an effort to maximize the positive effects on economic performance.

5.3 | Implications for policymakers

Our results are also of interest for policymakers. Considering the pressing "grand challenges" affecting our era (Foray et al., 2012; Kuhlmann, 2014), policymakers are increasingly aiding the emergence of CE practices, both at single firm level (Rainville, 2021), and at ecosystem level (Homrich et al., 2018). Indeed, a greater understanding of CE economic benefits, on top of social and environmental ones, will further encourage its adoption by firms which may receive these economic advantages. Therefore, the CE may prove to be an effective means to achieve benefits for all three pillars of sustainability—the economic, the social, and the environmental (Cappa, Rosso, & Capaldo, 2020; Cappa, Rosso, Giustiniano, & Porfiri, 2020; Hansmann et al., 2012; Inigo & Blok, 2019). Based on our results, policymakers may further spread CE practices among companies by stimulating its adoption at the optimal level for benefiting firm performance. Moreover, we encourage policymakers to introduce more powerful instruments that would allow extremely CE-active companies to exhibit

their efforts regarding CE activities to their customers. To date, a number of frameworks for CE certification coexist, making their recognition less straightforward. Moreover, customers are unable to precisely identify their effort regarding CE activities. In fact, customers need to be able to distinguish firms located on the left side of the curve, that is, moderately active in CE, from the firms located on the right side of the curve, that is, those that are "too active." We invite policy makers to introduce more "customer-friendly" instruments that might ease the identification of the level of CE activities undertaken by companies. This mechanism would overcome the typical pitfalls of the current CE certification system, where the dichotomic nature of the certificates, which measure only whether the firm is active or not in CE activities, limits an assessment of the number of activities undertaken, and therefore their CE breadth. Otherwise, customers are unable to perceive a firm's level of engagement in the CE (i.e., low or high), since the certification does not distinguish this dimension.

All in all, a transition toward the CE needs an integrated effort from companies, institutions and policy makers, (Parajuly et al., 2020). The lack of collaboration among the actors around the CE phenomenon might represent a significant barrier, especially for SMEs which are characterized by limited resources (García-Quevedo et al., 2020). Therefore, a proactive role of policymakers and governments in light of the outcomes of this study might be extremely beneficial for the further diffusion of CE.

6 | CONCLUSIONS

This study sheds further light on the growing phenomenon of the CE by demonstrating its curvilinear effect on company economic performance. Moreover, by indicating the right level of CE breadth needed to maximize a firm's turnover increase, the findings of this research also provide advice on how much effort should be devoted to CE activities, revealing a less positive effect generated by excessive CE efforts. Considering the great deal of scholarly, management and policymaking attention this topic has attracted, these results provide a greater understanding of the effects produced by CE activities for a wider audience as well as insights on how to effectively implement activities in order to maximize benefits.

The study is not exempt from limitations, though these may prove to be interesting for future developments. First, this dataset focuses on European Union countries, whereas future studies could explore what happens in other regions to see whether the results are in line with ours or if there are differences, in order to further define the right balance for the CE activities in each area worldwide. Also, a more in-depth investigation on what happen in the different regions within European Union and worldwide could provide additional insightful results, thus future research might focus on geographical areas to enrich our understanding. Moreover, the dataset was collected through surveys and is therefore based on self-assessment, whereas it might be extremely interesting to collect certified data or conduct interviews for further analysis to validate these results. Third, our dataset provides a one-year observation set, thus limiting the analysis of the effect of CE actions on turnover over time. We encourage future researchers to consider longer time horizons, which would also enable them to isolate the reciprocal effect of turnover increases on CE activities. Fourth, different economic performance variables could be explored. Lastly, as this research was conducted with data coming from SMEs, future studies should also analyze what happens in the context of larger companies.

Finally, given the strong relation of CE with sustainability, and given that CE has been identified as an enabling factor to achieve sustainability goals, future research could explore how the number of CE activities undertaken impact on the ESG scores, in order to widen the angle from the effects on economic performance to a more sustainable-related understanding.

ACKNOWLEDGMENT

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. (2023). Walking the tightrope: Circular economy breadth and firm economic performance. *Corporate Social Responsibility and Environmental Management*, *30*(4), 1869–1882. https://doi.org/10.1002/csr.2460