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The Effect of Phases of the Adoption of the Circular Economy on Firm Performance: Evidence from 28 EU Countries

Ilija Moric [1], Jelena Šaković Jovanović [2,*], Rajka Đoković [3], Sanja Peković [1] and Đurđica Perović [1]

[1] Faculty of Tourism and Hotel Management, University of Montenegro, Old Town 320, 85330 Kotor, Montenegro; imoric@t-com.me (I.M.); psanja@ucg.ac.me (S.P.); duda@ucg.ac.me (Đ.P.)
[2] Faculty of Mechanical Engineering, University of Montenegro, Cetinjska 2, 81000 Podgorica, Montenegro
[3] Faculty of Law, University of Montenegro, The street of July 13th 2, 81000 Podgorica, Montenegro; rajkadj@ucg.ac.me
* Correspondence: jelenajov@ucg.ac.me

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Abstract: Although a substantial body of literature has analysed the potential benefits of the circular economy, empirical evidence on the relationship between circular economy-related activities and firm performance is scarce. Rather than analysing only the effect of the circular economy on firm performance, we empirically examine the effects of the different phases of the adoption process of the circular economy on firm performance. Therefore, in this paper, a multiphase framework of circular economy adoption is developed. Employing a propensity-score-matching model on the sample of more than 4000 European SMEs, we show that the adoption of circular economy activities improves firm performance as measured by productivity. In addition, our findings reveal that the impact of circular economy activities on firm performance is dependent on the different phases of the adoption process. Taken together, this study enriches current research on the circular economy by contributing to a more nuanced understanding on the relationship between the different phases of the adoption process and firm performance.

Keywords: circular economy; firm performance; multiphase adoption approach

1. Introduction

Increased social awareness regarding resource scarcity, waste generation, and other environmental impacts have compelled the business community to explore resource-efficient opportunities. The circular economy (CE) is identified by leading international organisations (e.g., the United Nations and the European Union) as a mechanism that can help firms to realise economic advancements in an environmentally sustainable manner [1]. For instance, the European Union plans for a circular economy are defined by its 2018 Circular Economy Package which also contains the Action Plan. EU co-legislators (European Parliament, Council of the EU) were also involved in implementing the legislative actions included in the Action Plan.

The concept of the circular economy is not new [2], as it relies on sustainable development and other similar concepts related to environmental issues [3]. In reality, it is a fast-growing concept in which the value of products, materials, and resources is preserved as much as possible, while the waste production is minimised [4]. As argued by several scholars [5,6], the circular economy is grounded on the 3R approach: reducing, reusing, and recycling. What is more, Chine is the first country to have adopted the CE promotional law which applies the 3R principles. The CE is a restorative and regenerative approach that minimises resource use, energy leakage, and waste by closing the energy and material loops [1,7,8]. Therefore, the circular economy is a model for

the efficient utilisation of already produced assets, which is in distinct contrast to the 'linear' and 'open-ended' models [9,10]. Based on a comprehensive literature review, in [11] the CE was defined as an economic system that operates at micro, meso and macro levels and switches the 'end-of-life' concept to the concept that is focused on sustainable development. Moreover, working on a sample of 128 circular start-ups, [12] distinguished between five circular archetypes: design-based, waste-based, platform-based, service-based and nature-based.

The broad consensus in this literature is that the investment in the circular economy can generate positive effects on firm performance [7,8,11,13–17]. More precisely, it is considered that firms could profit from the circular economy adoption through the generation of environmental benefits associated with the reduced impacts and resource usage, cost savings generated from reduced natural resource requirements, and the new markets formation [13–15]. In other words, the predominant aim of a business model based on the circular economy is to help firms to generate value through the utilization of resources in multiple cycles, and waste and consumption reduction [18]. Although there have been considerable analyses that have discussed the advantages associated with the adoption of the circular economy, there has been surprisingly little empirical research that has determined the link between the circular economy and firm performance [8]. In most studies, the emphasis was on determinants and obstacles of the circular economy implementation [1,6,19,20]. For instance, [1] distinguished between soft and hard drivers/barriers associated to the CE. Soft factors are related to institutional/regulatory and social/cultural issues, while hard factors are concerned with technical and economic/financial/market matters. Moreover, based on a survey of 208 respondents and 47 expert interviews, [21] identified that cultural barriers, a lack of consumer interest and awareness, as well as a doubtful firm culture, are the main circular economy barriers. In addition, a related strand of work has explored the effect of environmental practices, environmental innovation, environmental technologies, and sustainability on firm performance, mainly underlining improvement in firm performance due to the adoption of environmental activities [22–28]. Therefore, in this study, this gap is addressed by studying the relationship between activities related to the circular economy and firm performance.

Moreover, several scholars have emphasised that the CE should be considered in various adoption phases [20,29,30]. In fact, [31] conceptualised innovation adoption as a multiphase process emphasises that the determinates of innovation may have a different impact at different stages in the adoption process. However, while a multiphase process of innovation adoption is acknowledged in the literature, understanding regarding the effects of the different phases of the adoption process on firm performance remains limited. The study of [32] stressed that prior studies did not consider the transition process of the adoption of innovation-related activities by distinguishing between different adoption phases. Accordingly, this study will differentiate the circular economy adoption phases as we presume that the CE–firm performance relationship might depend on the adoption phase considered. This is because in each sequent phase of the adoption process, firms can gain additional expertise which would be essential for performance improvement. More precisely, to understand how the adoption of the circular economy at different phases influences firm performance, four types of adopters are created. The first category, denoted 'Adopters', includes firms that have previously adopted practices associated with the circular economy; the second category, denoted 'Prospective Adopters', includes firms that are in the process of implementing circular economy practices; the third category, denoted 'Planners', includes firms that did not implement practices associated with the circular economy, but they are planning to do so; finally, the fourth category, denoted 'Non-Adopters', includes firms that did not and do not plan to implement any of practices associated with the circular economy. This categorisation will aid in determining whether the effect of the circular economy on firm performance is dependent on the adoption phase.

The present study makes three main research contributions. First, we will empirically examine the effect of the circular economy-related activities on firm performance measured by productivity. Although previous research has confirmed that circular economy adoption generates positive impacts for firms, further empirical examination is needed to better understand this relationship. Second, we

extend previous research associated with the adoption of environmental activities by analysing how different phases of the adoption of the circular economy affect firm performance. In this sense, the study sheds more light on the importance of adoption phases when exploring the role of the circular economy. Third, using data on European SMEs, we provide important insight regarding the role of the circular economy in SMEs. As emphasised by [8] and [16], the focus has been mostly on larger firms, while there is also a need for a systematic analysis that investigates practices associated to the circular economy in SMEs. Providing further analysis concerning benefits related to the adoption of the circular economy will help firms to overcome barriers related to the dearth of knowledge about the advantageous of the circular economy recognized in the previous literature [14].

We expect that our findings will underscore the importance of the circular economy in SMEs and provide a more nuanced explanation of the link between the circular economy and firm performance.

This paper is organised as follows. Section 2 presents the theoretical background and the development of hypotheses. Section 3 describes the data and the empirical model. Section 4 provides the findings. Section 5 concludes the paper and provides practical implications.

2. Literature Review

In [7], it is underlined that even the main objective of the CE adoption is to reduce waste and pollution, it has also the ability to produce economic value for firms by decreasing input, increasing efficiency, and waste prevention. In fact in [11], it was stressed that the main purpose of the circular economy is associated with economic prosperity, followed by environmental quality; and its impact on social equity. In [2], it was explained that to gain economic benefits, firms mainly depend on necessary resources that are further influenced by price and supply risks. The authors proposed the CE business approach as a valuable source of competitive edge, that can help a firm to reduce the speed of resource depletion and waste generation. Accordingly, in [17], it was argued that the adoption of practices associated to the circular economy will extend the useful life of a product while minimising resource use and waste, which could be reflected directly in the improvement in financial performance. More precisely, the author stressed that the adoption of the circular economy infers income smoothing, instability reduction and improved customer retention, which leads to steady cash flow growth. In the same vein, previous scholars [18,33,34] agreed that reuse and redistribution yield high profitability and eco-effectiveness obtained by a positive economic and ecological I-O ratio. Similarly, in [35], it was indicated that the investment in the circular economy maximises the overall value of products and, eventually, the materials they are made from by taking an overall system perspective. In this regard, the authors gave an example of how polyethylene recuperated from packaging can be utilised to produce cloths. The Ellen MacArthur Foundation [36] has run several estimations confirming that the adoption of circular economy activities generates significant cost savings. The analysis further revealed that innovations sustaining the circular economy would help Europe's resource productivity to raise by 3% by 2030, equalling €1.8 trillion.

The previous discussion was empirically confirmed in [16], one of the few studies that examined the link between the circular economy and firm performance. More precisely, working on a sample of European SMEs, the authors revealed that only re-planning the energy usage to minimise consumption does not influence economic performance, while the use of renewable energy, the re-planning of water usage, the minimisation of waste, and the minimisation of the use of materials represent decisions that are both favourable for the environment and produce improved economic performances. In [8], a positive effect was revealed; however, their findings indicate that firms have to invest more than 10% of revenues into the circular economy in order to benefit from it.

An additional rationale concerning the positive link between the circular economy and firm performance could be traced in the environmental practices/innovation literature. The rationale is supported by the fact that environmental innovation can be used as a transformative tool to outdistance from the status quo and establish a CE oriented system [1]. Previous findings support the positive impact of environmental innovation on firm outcomes [37–41]. Turning to environmental practices,

they are also assumed to generate significant economic benefits to firms [22,23,25–28]. Furthermore, [42] itemised various means through which environmental investments provide financial gains to firms, such as better access to markets, possibility for differentiation of products, commercialisation of pollution-control technology, and savings on regulatory, material, energy and services, capital and labour costs.

The literature has recognised innovation adoption as a multiphase process since it may occur at different stages [31,43–46]. In [31], it was stated that the general categorisation of these phases is preadoption, adoption decision, and post-adoption, which are usually denoted as *initiation*, *adoption (decision)*, and *implementation*, respectively. The authors further stated that the *initiation phase* is related to identifying a need, seeking for solutions, becoming aware of existing innovations, recognizing suitable innovations, and suggesting some for adoption, while *adoption decision* includes the assessment of the suggested ideas from technical, financial, and strategic aspects, the decision making to accept an idea and provision of the resources for its acquisition, alteration and assimilation. Finally, in the *implementation phase*, the innovation is applied by organisational members and customers. It is noteworthy that scholars have emphasised that the determinates of the innovation adoption process diverge between the different phases of adoption [31,32]. Nonetheless, the literature contains gaps in discussing how different phases of innovation adoption enhance firm performance. One exception is in [47]; that study's findings reveal that firms at more advanced adoption phases have higher performance scores.

Bearing in mind the above discussion regarding the importance of different phases of innovation adoption, we advocate a multiphase approach based on a three-phase framework. We assert that the category of Planners refers to the *initiation phase*; Prospective Adopters are in the phase of the *adoption decision*; finally, Adopters are in the *implementation phase*. Furthermore, we reason that because Adopters are in the *implementation phase* that characterises the technical process of creating the value of the adopted innovation as well as its operationalisation [48], they will benefit more from the adoption of the circular economy than other categories of adopters, including Prospective Adopters. Furthermore, as Prospective Adopters, who belong to the *adoption decision* phase (also called 'pilot phase') make circular economy activities more visible to the whole firm [32], we assume that their benefits generated through the circular economy implementation will be higher than those from firms belonging to the category of Planners. Finally, Planners belong to the *initiation phase*, in which organisational members learn about innovation's existence, recognize its suitability for the firm, communicate with others and propose its adoption [31], which creates knowledge and working environments that support circular economy adoption and makes them in a more beneficial position regarding firm performance improvement than Non-Adopters.

Taken together, these arguments suggest that:

H1a. *The performances of the firms belonging to the category of Adopters are higher than those of Prospective Adopters, Planners, and Non-Adopters.*

H1b. *The performances of the firms belonging to the category of Adopters are higher than those of Prospective Adopters.*

H1c. *The performances of the firms belonging to the category of Prospective Adopters are higher than those of Planners.*

H1d. *The performances of the firms belonging to the category of Planners are higher than those of Non-Adopters.*

3. Empirical Strategy

3.1. Data

In order to preform our empirical analysis, we employed Flash Eurobarometer 441 called *European SMEs and the Circular Economy*. The data collection was coordinated by the European Commission and

TNS during 18 to 24 April 2016. A total of 10,618 SME from 28 member states of the European Union were interviewed, including several sectors of activity, such as manufacturing, industry, retail, and service. The survey was done to analyse firms' investment in the circular economy, firms' awareness of available financial sources related to the circular economy investment, the most used finance sources, the quality of information accessible to help firms to access finance, various issues associated with undertaking actions concerning the circular economy, and firms' knowledge of government programs that actions associated to the circular economy. These data have been used by a large number of scholars [6,8,14,49]. For instance, using the same data, [6] explored firm's characteristics that determine the CE practices while [49] contributed to the understanding of the circular economy, of its different dimensions, and the difficulties experienced by SMEs. In [8], the effect of the circular eco-innovations and external funding available for the CE activities on the growth of European SMEs was examined. Moreover, using a decision three model, [14] analysed the business strategies associated to the implementation of the circular economy practices and the optimal level and nature of investments in the circular economy for improving economic performances. We enriched previous studies by demonstrating that the impact of the circular economy activities on firm performance is dependent on the different phases of the adoption process. Noteworthy, our empirical strategy permitted us to control for the selection bias.

We eliminated firms with missing relevant information for our analysis. Therefore, our final sample contained 4237 observations.

3.2. Dependent Variable

Following previous studies [27,50,51], our dependent variable named *PRODUCTIVITY* was conceptualised as a logarithm of sales per employee. It is noteworthy that productivity is considered to be a common measure of firm performance. In addition, as suggested in [51], productivity permits comparisons across industries and countries since it is not influenced by firms' accounting and financing decisions.

3.3. Independent Variable

We first created four variables that will further serve to test the effect of different phases of the adoption of the circular economy on firm performance. The first category, denoted 'Adopters', included firms that adopted at least one type of activities related to circular economy, i.e., (a) re-plan the way water is used to minimise usage and maximise re-usage, (b) use of renewable energy, (c) re-plan energy usage to minimise consumption, (d) minimise waste by recycling or reusing waste or selling it to another firm and (e) redesign products and services to minimise the use of materials or use recycled material. The second category, denoted 'Prospective Adopters', included firms that are in the process of implementing at least one type of the activities related to the circular economy. The third category, denoted 'Planners', included firms that did not implement at least one type of the practices allied to the circular economy, but they are planning to do so. The last, fourth category, denoted 'Non-Adopters', comprised firms that did not and do not plan to implement any of activities related to the circular economy.

3.4. Control Variables

In line with previous scholars [6,16,26,41,52,53], we used several control variables. Firstly, as stressed in [54], older firms are less keen to adopt innovation-oriented activities due to organisational inertia. Accordingly, we created the variable *YEAR*, which indicates the time frame in which the firm was established. Secondly, investment in environmentally related activities, such as the circular economy, is positively related to the firm size [26,52,53]. Therefore, we created the variable *SIZE*, which represents the firm's number of employees. Thirdly, in [17] it was discussed that firms that invest in R&D activities also invest more in green activities as they have established the internal innovative capabilities. Accordingly, we created the variable *R&D*, which represents the percentage of a firm's

turnover allocated in R&D activities. Fourthly, the type of market is considered to be an important determinant of a firm's likelihood of adopting the circular economy associated practices. In [6], it was found that firms selling directly to consumers invest more in the circular economy. We, therefore, created two variables: *B2B*, which indicates that a firm sells to firms or other organisations, and *B2C*, which indicates that a firm sells directly to customers. Finally, given the importance of the sector of activity acknowledged by previous scholars [26,52,53], we distinguished between four types of sector: *MANUFACTURING*, *RETAIL*, *SERVICE*, and *INDUSTRY*.

In Table 1, we present the descriptive statistics for the study's variables.

Table 1. Definition of variables and descriptive statistics (N = 4237).

Variables	Definition	Mean	SD	Min	Max
PRODUCTIVITY	Logarithm of total annual sales per employee (Continuous variable)	11.52	1.63	2.48	18.06
ADOPTERS	The firm adopted at least one type of practices associated to the circular economy	0.55	0.50	0.00	1.00
PROSPECTIVE ADOPTERS	The firm is in the process of adopting at least one type of the practices associated to the circular economy	0.20	0.48	0.00	1.00
PLANNERS	The firm did not implement at least one type of the practices associated to the circular economy, but they are planning to do so	0.06	0.46	0.00	1.00
NON-ADOPTERS	The firm did not and does not plan to implement any of the practices associated to the circular economy	0.19	0.39	0.00	1.00
AGE	The firm was established: (1) Before 1 January 2010. (2) Between 1 January 2010 and 1 January 2015 (3) After 1 January 2015	 0.85 0.14 0.01	 0.36 0.35 0.11	 1.00 1.00 1.00	 0.00 0.00 0.00
SIZE	Number of employees (Continuous variable)	20.94	37.97	1.00	250
R&D	The percentage of the firm's turnover that was allocated for Research and Development in 2015 (Continuous variable)	3.42	10.54	0.00	100
B2B	The firm sells products/services to firms or other organizations	0.37	0.48	0.00	1.00
B2C	The firm sells products/services directly to consumers	0.68	0.46	0.00	1.00
MANUFACTURING	The firm belongs to the manufacturing sector	0.14	0.35	0.00	1.00
RETAIL	The firm belongs to the retail sector	0.32	0.47	0.00	1.00
SERVICE	The firm belongs to the service sector	0.39	0.49	0.00	1.00
INDUSTRY	The firm belongs to the industrial sector	0.15	0.36	0.00	1.00

3.5. Empirical Model

Investing in practices associated to the circular economy may not be random since it can be contingent on a firm's features. Likewise, a firm may implement practices associated to the circular economy because of specific need or conditions, which induces selection bias. To bypass potential bias, we employed matching estimators [55]. The model could be employed for all situations in which one has received a treatment, a treated group and an untreated group.

We defined T as a binary variable with a value of 1 if the firm received a treatment, i.e., belonging to the category of Adopters, Prospective Adopter or Planners. The benefit of the treatment was assessed through the result y_i. Hence each firm had two possible outcomes: y_0 (if $T = 0$) and y_1 (if $T = 1$). y_0 and y_1 are never detected at the same time, as a firm is either is treated, or untreated. Particularly, only the real situation of the firm, noted Y, is perceived: $Y = y_1T + y_0(1 - T)$. In our case, T is a binary variable representing if the individual received a treatment or not ($T = 1$ if the individual is treated, T = 0 if not).

Therefore, we defined four comparison models:

- In Model 1, T = 1 if the firm belongs to the group of Adopters and T = 0 if the firm is considered as a Prospective Adopter or Planner or Non-Adopter.
- In Model 2, T = 1 if the firm belongs to the group of Adopters and T = 0 if the firm is considered as a Prospective Adopter.
- In Model 3, T = 1 if the firm is a Prospective Adopter and T = 0 if the firm is a Planner.

- In Model4 T = 1 if the firm is a Planner and T = 0 if the firm is a Non-Adopter.

Aiming to correct for selection bias, we built four samples. For example, in Model 2, we removed firms that belong to a group of Planners or Non-Adopters.

We presented productivity as y and assessed the impact of each treatment on *y*.

The propensity score creates a one-dimensional summary of the matching variables. Furthermore, the score evaluates the probability of receiving the treatment, conditionally to these variables. In this paper, the matching principle is based on kernel techniques in order to deliver a non-parametric assessment of the treatment effect given the value of the propensity score [56,57]. In addition, to compute the standard error for the kernel estimator, we adopt a bootstrap technique.

4. Results

Consistent with our aim, the results on the link between the circular economy and productivity are presented according to the different phases of circular economy adoption. The results are presented in Table 2.

Table 2. The effect of phases of the adoption of circular economy on productivity.

Observed Coefficient	Bootstrap Standard Error	Z Value
Model 1: Adopters vs Prospective Adopters and Planners and Non-Adopters (N = 4237)		
0.31 ***	0.05	6.76
Model 2: Adopters vs Prospective Adopters (N=3193)		
0.13 **	0.06	2.01
Model 3: Prospective Adopters vs Planners (N=1083)		
0.24 ***	0.11	2.21
Model 4: Planners vs Non-Adopters (N=1044)		
0.11	0.11	0.97

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

As could be noted in the Model 1, Hypothesis 1a, asserting that the performances of the firms belonging to the category of Adopters are higher than those of the Prospective Adopters and Planners and Non-Adopters, is supported by our findings ($b = 0.31$, $p < 0.01$). Therefore, firms that invest in the circular economy activities are more competent as they recycle and reuse their utilised products in a more resourceful manner but also as they develop more stable and interactive relationships with their customers [17]. In accordance with our findings, McKinsey's (2015) report [34], which analysed the systems for three human needs (mobility, food, and the built environment), revealed that the implementation of CE principles could decrease the total cost in the three sectors by €0.9 trillion annually by 2030 versus today—or a reduction of 12% in Europe. More precisely, employing extensive desk research, more than 150 interviews, economic modelling, the largest comparative study, and deep analysis of three human needs, the report indicated that: "*The average cost per car-kilometer could drop as much as 75 percent, thanks to car-sharing schemes, autonomous and driverless driving, electric vehicles, and better materials. In food, precision agriculture could improve input efficiency of water and fertilizers by at least 20 to 30 percent, and combined with no-tillage farming, it could reduce machinery and input costs by as much as 75 percent. In buildings, industrial and modular processes could lower construction costs by 50 percent compared with on-site traditional construction. Passive houses could reduce energy consumption by 90 percent*". In the same vein, the EU-LAC Foundation presented several real case studies in [58] that supported our findings regarding the positive impact of the CE on financial performance. For instance, Neptuno recorded sales growth of 25% per year and reported a hiring rise of 15% per annum since 2016, Pulpo's annual sales increased by 50%, and Ananas Anam sales augmented from around Euro 600,000 in 2018 to Euro 2,800,000 in 2019. In addition, Accenture's analysis [59] suggested that the CE could generate $4.5 trillion of additional economic output by 2030.

Furthermore, we worked only on the sample of Adopters and Prospective Adopters, excluding firms that appertain to the category of Planners and Non-Adopters (N = 3193), which permitted us to test Hypothesis 1b. As could be observed in Model 2, the performances of the firms appertaining to the category of Adopters are higher than those of Prospective Adopters; therefore, we confirm Hypothesis 1b ($b = 0.13$, $p < 0.05$). Comparing the obtained coefficients in Model 1 and Model 2, we may observe that the coefficient in Model 2 is considerably lower than in Model 1. This could imply that firms that are considered to be Prospective Adopters could gain significant benefits in this phase of the adoption process. However, it should be underlined that the activities associated to the circular economy should become a routine feature of the firm [31] in order for the firm to profit from its implementation in full capacity. Furthermore, firm's competencies regarding the CE evolve in each sequent phase of adoption, which is also reflected in firm performance improvement. What is more, each sequent phase of adoption improves a firm's ability to develop adequate strategies that would amplify the positive effect of the CE on firm performance.

The results also support Hypothesis 1c, as presented in Model 3, which states that the performances of the firms appertaining to the category of Prospective Adopters are higher than those of Planners ($b = 0.24$, $p < 0.001$). In order to test this hypothesis, we worked on the sample of 1083 firms and we excluded firms belonging to the category of Adopters and Non-Adopters. The obtained results suggest that firms already in the *adoption decision* phase may achieve extensive improvements compared to firms in the *initiation phase*. As expected, the firms belonging to the *initiation phase* improve less in firm performance than the firms belonging to the *adoption decision* phase, given that firms in this phase have limited competencies, knowledge and skills related to the CE practices. Therefore, it could be concluded that the firms in the *adoption decision* phase identify and profit from the unexplored potential related to the CE more than the firms in the *initiation phase*.

Model 4 shows results suggesting that the performances of the firms belonging to the category of Planners are not significantly higher than those of Non-Adopters ($b = 011$, ns), rejecting Hypothesis 1d. Similarly to previous cases, we eliminated firms belonging to the category of Adopters and Prospective Adopters, due to our sample containing 1044 firms. Our results thus indicate that tangible investment associated with the circular economy is necessary in order to distinguish Planners' benefits than those from Non-Adopters. This could be also due to the fact that the firms belonging to the category of Planners did not yet acquire enough expertise associated to the CE that could be translated into firm performance improvement. Therefore, they need further organisational changes that are oriented to the CE practices in order to advance their performance.

This article builds on and extends previous work [7,8,13–17] that provides the theoretical argument acknowledging that investment in the circular economy results in superior firm performance. In fact, in addition to providing empirical evidence that the effect of the CE on firm performance is positive and significant, the findings reveal that the CE adoption phases influence the relationship between the CE and firm performance. Our findings regarding the categories of Adopters and Prospective Adopters emphasise that in each sequent phase of adoption, firms gain the knowledge resources necessary for achieving superior economic performance (compared to the prior adoption phase). However, tangible investment is needed in order to fully profit from the circular economy adoption as it was confirmed when comparing productivity between Planners and Non-Adopters. Thus, unlike the analyses of [14] or [8] that yielded only evidence regarding the effect of the CE on firm performance, our approach shows that the positive performance outcome is dependent on the phases of the adoption process. By employing a propensity-score-matching model, our study also provides a significant contribution from an empirical perspective, as we control for selection bias.

5. Conclusions

In an effort to improve their competitiveness, firms have started to invest in the circular economy; the traditional linear economic production and consumption model is being replaced by the circular one [6,8,16]. The existing efforts in the literature have tended to emphasise the benefits of activities

related to the adoption of the circular economy [7,8,13–17]. However, that authors of [8] recently called for more empirical analysis that examines the potential benefits that the investment in the circular economy may generate. Moreover, to fully comprehend the influence of the circular economy on firm outcomes, we need to understand the different phases of circular economy adoption. Therefore, drawing on a multiphase approach, we investigate, employing the propensity-score-matching method, how different phases of circular economy adoption influence firm performance measured by productivity.

Our analysis of more than 4000 SMEs from 28 EU Member States suggests that the implementation of practices related to the circular economy positively influences productivity, which supports our first hypothesis. This finding is consistent with the argument that the investment in the circular economy generates, along with environmental benefits, economic ones through resource use and waste minimisation [7,8,13–17].

The further analyses show that the productivity of Adopters is higher than that of Prospective Adopters, which is, in turn, higher than that of Planners. These findings are in line with Hypotheses 2 and 3. However, Planners do not have higher productivity than Non-Adopters, indicating that an established system regarding the circular economy is pre-conditioned for firms' performance improvement. Accordingly, Hypothesis 4 is not supported. The findings also demonstrate that each phase of the adoption process helps a firm to develop additional competencies that are beneficial for firm performance, but this conclusion holds only when a firm has already made the first steps associated with the adoption of circular economy activities (the second and third phases). In this sense, this research contributes to the theoretical perspectives of the innovation literature, as it presents one of the first empirical researches to clearly test the link between different phases of the adoption process and firm performance. Prior research has paid considerable attention mainly to the drivers of different adoption phases [31,32,60,61], but our findings provide evidence that in each sequent phase of adoption firms gain new knowledge, which enhances firm performance more than in prior phases but only for the categories of Adopters and Prospective Adopters. In addition, it could be concluded that concrete actions related to the circular economy adoption are necessary in order for a firm to benefit from its implementation. In other words, knowledge created associated with the circular economy during the *initiation phase* is not sufficient to create significant benefits for Prospective Adopters in comparison to Non-Adopters.

We believe our results cast a new light on the existing literature associated with the circular economy and innovation adoption by emphasising that the adoption of the circular economy positively affects firm performance, but its effect also depends on the phase of the adoption process.

5.1. Managerial Implication

From a managerial viewpoint, our results provide evidence that the implementation of the circular economy related practices has the potential of being an important performance improvement tool for managers. Furthermore, while the investment in the circular economy positively affects productivity, the adoption is a complex process, in which each phase of adoption has different effects on the firm's performance. Therefore, managers need to understand and prepare each phase of the adoption process to accrue significant performance effects. Furthermore, as demonstrated by our analysis, managers should be aware that the improvement in the firm's performance requires tangible investment related to the circular economy. Therefore, they should be patient since the benefits may not be observed in the first phase of the adoption process. However, this phase is equally important, since managers should create an environment that supports the adoption of the circular economy, which would help smooth the implementation of the other two phases.

5.2. Limitations and Future Research

Our study is not without limitations, suggesting future research opportunities. First, the hypothesis testing was conducted with cross-sectional data, but future analyses should employ panel data to analyse these relationships over time. Second, empirically, we only explore one outcome of firm

performance. Additional research should examine other potential indicators of performance, such as profit, ROA, ROE, and others. Third, while our discussion is general, our findings may have limited transferability to large firms. Thus, future research should also include large firms in order to obtain a more generalised conclusion. Fourth, analyses of contingencies factors, such as market characteristics [23,62], should be investigated as potential moderators when examining the link between the circular economy and firm performance. Finally, in order to gain a more grounded understanding related to the relationship between different adoption phases and firm performance, future research should extend this analysis, including more information associated with each adoption phase.

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