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Financial Resources for the Circular Economy: A Perspective from Businesses

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Abstract: In recent years, a number of case studies of the circular economy in business have been analysed by academics. However, some areas of research are little explored at the micro level, such as the study of the characteristics of the financial resources applied to investments to introduce circular activities in businesses. Therefore, the main objective of this study is to define the resources applied to circular activities by firms. To describe the influence of financial resources on achieving a more advanced circular economy in business is also an objective of this paper. Using a sample of Spanish companies, we applied a partial least square structural equation model (PLS-SEM) to enhance the knowledge about financial resource management in the framework of the resource-based view. We find that availability of funds, quality of the firm's own financial resources and public subsidies have a positive effect in stimulating the implementation of circular economy initiatives in businesses.

Keywords: Financial resources management; circular economy; sustainability; resource-based view; environmental management accounting; corporate finance

1. Introduction

In this decade, the circular economy (CE) has been promoted as an approach to sustainable development that does not compromise economic growth [1]. The number of academic studies on the CE are increasing and different authors have reviewed its different definitions and approaches [2–7]. The introduction of the CE in businesses has also been analysed [8] due to the increasing interest of companies toward CE [9,10]. However, knowledge about how companies are adopting the principles of CE is still under investigation in the current literature [10].

Although there is a lack of studies specifically addressing matters of the CE at the micro level, scholars have investigated other factors that influence companies' commitment to the environment. Some examples are eco-innovation processes [11], eco-design [12,13], compatibility with existing production processes, capital life-cycle or the high initial direct costs of investment, and the exploitation of renewables [14]. Studies of eco-innovation are related to the CE since the introduction of environmental aspects in the design of products allows sustainability to be integrated in the production of goods [15]. Eco-design facilitates the CE in businesses since it contributes to closing the production loops by separating components and by preventing their obsolescence. Additionally, eco-design facilitates recycling and the reintegration of products into the economic system.

However, the study of specific internal resources and capabilities of companies related to the CE is at an early stage. In fact, to the best of our knowledge, a broad investigation remains open regarding the definition and measurement of different characteristics of financial resources for the CE, although financial attractiveness can be considered today as a relevant aspect for the circular business model [16].

A number of the studies conducted within the resource-based view (RBV) framework analyse resources or capabilities related to eco-innovation [17] without offering total clarity concerning those resources required to finance the introduction of the CE at the micro level. In particular, identifying resources that are specifically applied to CE investments is a new line of enquiry. Financial resources applied to some of the different aspects of the CE, such as renewables, eco-innovation or to more general investments for environmental improvements have been addressed in the literature [18]; however, the combined effects of the characteristics of financial resources have not been considered with CE investments in the same analytical framework.

Therefore, the main objective of this study is to define and measure different characteristics of financial resources applied to the CE by firms. In summary, this study goes beyond previous research approaches related to the CE to extend knowledge by proposing connections with financial resource literature in the framework of the RBV. The analysis builds on and extends the research field on the CE by addressing both theoretical and methodological issues related to the definition and measurement of financial resources applied to CE activities by businesses.

To this end, a model of the cause-and-effect relationship between the CE scope achieved by businesses and the level of investment has been designed using partial least squares structural equation modelling (PLS-SEM). The model has been tested in a sample of companies in Spain that demonstrate special interest in eco-innovation, eco-design and some of the circular activities. Data was collected through the active collaboration of private businesses, which is required for analysing the financial resources that are needed to introduce the CE in firms.

This paper is organized as follows: a literature review is presented in the next section, before a description of the method and the sample. Following the methodology, the results are summarised and discussed within the RBV framework to outline main conclusions and potential avenues for future research.

2. Background

Different studies have been developed relating to the CE due to its relevance to the search for solutions to improve resource efficiency, materials intensity and other sustainability issues throughout the value chain [19]. To date, the debate about the specificity of resources has focused more on resources and capabilities for environmental proactivity or eco-innovation. Given the high difficulty posed by the CE, few authors have explored this line of research, probably due to the multifaceted aspects involved in the CE. Nevertheless, the measurement of the CE and the theoretical frameworks to define related resources are still under investigation due to the fact that CE implementation in businesses is still at an incipient stage.

It is not easy to opt for a theoretical approach when analyzing the environmental performance of companies in terms of the CE, since this model includes actions that affect all the functional areas of the companies. Thus, the close relationship that the CE has with eco-innovation is taken into consideration. At the micro level, proactive environmental strategies to enhance eco-innovative attitudes among companies [20,21] and eco-innovation [11] have been widely studied. Additionally, internal factors that influence eco-innovation have also been analysed in the literature [22–25]. Resources and capabilities of firms are demonstrated to be relevant for eco-innovative businesses within the theoretical framework of the RBV [26–28] and the natural resource-based view [29]. When considered in the study of corporate finance, the RBV is applied to define resources that a firm is able to control to eco-innovate [17]. The RBV theory has also been combined with institutional or contingency perspectives in order to account for external pressures that may affect the environmental strategies adopted by firms and to determine the specific advantages in the execution of these strategies [30].

In this study RBV is considered as an adequate theoretical framework to understand whether specific resources applied to the CE by businesses are relevant for closing production loops without affecting the level of competitiveness. In particular, the main goals of this study are to analyse the financial resources applied to the CE activities in the framework of the RBV and to enhance the knowledge about the financial resources that are needed when the CE is adopted by businesses. The level of CE achieved by companies is measured through a wide number of investments and activities carried out by businesses. Furthermore, the characteristics of the applied resources are also explored to help industries to develop specific resources in order to increase their scope in terms of the CE.

2.1. Financial Resources and the Circular Economy

While the benefits of the CE are increasingly recognised, there are still many barriers hindering the transition to a circular model in businesses. Some authors indicate that the inadequate financial scheme, the lack of financial resources [31], and the lack of support from public institutions [16,32,33] cause the slower adoption of the CE. Insufficient investment and the risks associated with circular business are considered to be obstacles to achieving the transition towards a CE, particularly for small and medium-sized enterprises (SMEs) [34].

The risk for organizations to include the CE in their actual practices [10] is mainly due to new investments in recycling, recovery infrastructure and eco-technologies for closing the loops. Insufficient investments in these activities and infrastructure, as well as an insufficient level of funds applied to eco-innovation, are considered barriers to the CE. It can be considered as accepted that in order to address the risks associated with circular business, it is necessary to encourage learning and innovation, initiate business strategies and facilitate cross-sector collaborations [35].

A study of barriers to promoting clean technology in Chinese SMEs reveals that the exterior barriers of policy and financing are more relevant than the internal technical and managerial barriers [36]. Therefore, the availability of funding, especially for investments in technology, is critical for firms to implement CE practices. Shahbazi et al. [37] affirm that limited financial capability for environmental investments is a primary management issue. Sue et al. [36] show that large financial resources need to be invested in CE pilot projects. In particular, the new perspective on selling services rather than products implies that businesses will not receive payment at the beginning of the product's life cycle, such that the timing of cash flow is even more relevant in these investments [38]. Therefore, there are no doubts that circular business models require adapted financial mechanisms.

An example of advanced collaboration within the CE is industrial symbiosis [39,40]. Ghisellini et al. [41] demonstrate that the reasons for companies to be involved in these advanced solutions of the CE are to recover the costs involved with environmental investments. The tax cuts, refund policies on resource use and financial subsidies positively stimulate the development of industrial symbiosis. Aid et al. [42] point out that problems in financing synergy partnerships are a limitation to the development of eco-industrial parks and they discuss how taxes and government subsidies allow viable economies of scale. On a similar theme, Velenturf [43] considers that collaborative processes fomented through the CE involve stakeholders for co-producing or co-deciding, and also for financing projects.

Masi et al. [44] highlight the importance of financial support through subsidies and other incentives in the recycling industry, in which the investment supports for technology development are believed to be vital [45]. Different studies have also emphasised public subsidies as an element that facilitates research, development and innovation activities [46]. Regarding the environmental sphere, Tirguero et al. [47] and Ghisetti and Rennings [48] point out the positive effect of public subsidies for adopting environmental innovation in companies. Moktadir et al. [49] demonstrate that small companies need more support from government for the adoption of sustainable manufacturing practices because they do not have sufficient capital.

From the cited authors, economic instruments—including fiscal and financial incentives, direct funding, and public procurement—have to be considered as relevant resources to foment the CE [50]. However, the incipient stage of adoption of a CE by businesses does not allow an in-depth analysis of literature around specific financial resources applied to the circular processes in the framework of the RBV. It has to be taken into account that the CE is a complex model that includes different environmental issues and concerns different areas of investments, such as those devoted to the environmental improvements of the company, eco-innovation or energy saving, and renewables. From an analysis of the literature regarding the CE, it could be assumed that all these areas represent an adequate endowment of resources and capabilities of the companies to invest in new activities for closing loops, and that a higher level of related activities carried out by businesses would suppose greater environmental performance in terms of the CE. However, it should be noted that most studies available in this area refer to resources and internal capabilities of companies that are not specifically related to the CE [17,51–53]. Accordingly, in this study, the financial resources are defined and measured when they are directly related to different activities of the CE: environmental improvements, eco-innovation, eco-design for circularity and resource saving. Therefore, the analysis of the background has been enhanced in our study to also include previous literature about investments to improve the environmental performance of businesses, the financial aspects of investments in energy saving and renewables and the financial resources applied to more general aspects of environmental innovation.

The insufficient investments and the risks associated with the improvement of the environmental performance in businesses have been traditionally palliated through direct public funding, such as grants for R&D, piloting activities, research infrastructure, innovation vouchers, supporting innovation incubation, etc. [34]. Likewise, tax reduction for recycled products has been proposed to increase their consumption and to promote the CE [34]. Few authors have delved into the analysis of these specific factors [54] given the great difficulty of differentiating the specific resources and capabilities of companies applied to the environmental investments by firms. Some authors focus their interest specifically on financial resources [55–57], access to capital, either through credit institutions or venture capital, expansion of capital and own funds, or the availability of public funds [58].

In the eco-innovation field, the influence of different parameters inherent to financial resources applied to eco-innovative investments has been considered in more dimensions [47,59–62]. Volume, availability, qualitative aspects of financing and the allocation of public subsidies to promote these investments have been analysed [18]. However, the in-depth study of the resources and capabilities that enable environmental performance continues to be a subject of debate with regard to financial resources and their application to eco-innovation.

In previous studies, other aspects related to financing, such as the level and structure of company debt, have been considered as explanatory variables of a company's eco-innovation behaviour through their relationship with financial performance [62–66]. It has also been demonstrated that the associated uncertainty implies a higher level of collateral for the granting of loans related to high risk investments [67,68] and reduces the flow of funds towards this type of investment [69]. Thus, the results obtained in the eco-innovation field were taken into account in this study to define how to measure the quantity of funds allocated to CE activities by companies. The availability of financial resources and their potential restrictions are also included into the analysis as they could affect the investments on CE [70,71].

From another perspective, renewables are considered as a pillar of the CE. The aim of increasing the contribution of renewable sources to the total energy supply is of worldwide importance to mitigate the negative energy effects of climate change [72]. However, a large amount of investment is needed for the energy transition and a significant lack of investment has been pointed out in the renewable energy sector in different geographic areas [73,74]. The financing gap for renewables when businesses are involved in the CE process could be framed within the availability and the cost of capital (and risk) since they influence the attractiveness of projects to investors. In fact, renewable energy projects are typically financed with a mix of equity and debt [73].

Financial constraints are a pertinent feature of the energy industry. Ekholm et al. [74] demonstrate that energy projects are typically capital-intensive, large, lumpy and with long payback periods. If insufficient capital is mobilised towards these projects, under-investment will lead to adverse consequences, including from a CE perspective. Specific funds have been created in various contexts in response to under-investment in climate mitigation [75]. Additionally, it has to be taken into account that most electricity market investment has traditionally come through a utility model, based on low levels of risk and secure returns [76]. It is questionable whether this model would work for renewables that have to be implemented in a CE because such investments require more diverse methods of financing. The availability of private resources increases under the established public–private partnership agreements and opens new financing channels that can be available in a high growth of renewable energy sector [77].

Safarzyńska and Van den Bergh [78] state that an overly rapid transition to renewable energy can pose a serious burden on the financial system because investments in renewable energy increase the price of electricity. The need for subsidies is also pointed out for renewables by Frisari and Stadelmann [79], who consider that the high cost and perceived risks represent significant barriers to the deployment of stable and clean energy in developing countries, and that public financing to improve projects' financial profiles is required.

In this context, financial resources are needed to perform a circular business model [80]; however, the investigation of the different characteristics of financial resources for the CE remains open. Thus, in this study specific variables have been developed and tested in this study to measure and define the characteristics of financial resources applied to the CE by companies. In summary, Table 1 shows how financial resources have been analysed in the general framework of environmental performance, business eco-innovation and sustainable energy

Table 1. Definition of different characteristics of financial resources applied to the circular economy (CE) and authors that have used similar variables.

FINANCIAL RESOURCES	Authors
"Quality" of financial resources for the Circular Economy (CE)	
Collateral (guarantees) required for the CE	[18,67,69,73,81]
Costs of the external funds for the CE	[18,65,71,74,76,82–84]
"Availability" of financial resources for the CE	
Capital availability as a restriction	[31,37]
Uncertainty about the cash flows derived from investments in the CE	[42,83]
Source of financial resources for the CE	
Investments financed with the company's own funds. ("equity funds")	[77,85–90]
Incentives and public funds, etc.	[17,18,47,48,77,79,91–97]
Investments in energy valorisation and renewables	
Financial aspects of investments in energy valorisation and renewables	[35,73,74,76,77]
Investments in eco-innovation	
Investments in innovative solutions to reduce the company's environmental impact.	[17,18,98]
Investments in environmental R&D (internal or external) for eco-innovation.	[17,47,50,59–62,99,100]

Studies on barriers and incentives for the CE are also included since they consider financial resources, even in terms other than those covered by our study.

2.2. Circular Economy Measurement

In a CE, materials that can be re-circulated are injected back into the economy as new raw materials, increasing the security of supply. These "secondary raw materials" can be traded and shipped just like primary raw materials from traditional extractive resources [101]. Materials from products at the end of their lifecycle are recovered through dismantling and recycling to reduce environmental impacts and production costs. Recycling is therefore a necessary precondition for a CE that includes eco-design for recyclability, reuse and other environmental management practices, such as resource efficiency [13].

In order to elaborate on comparative assessments of CE performance across the European Union (EU), data from Eurostat, the Resource Efficiency Scoreboard and the Raw Materials Scoreboard are being used for tracking progress in terms of circularity. However, these metrics are not adequate to measure the CE in firms because they are mainly applied to measure materials and resource flows at the territorial level but not internally in a company. Thus, it is important to have a set of reliable indicators specifically designed to be applied to businesses. To this end, in this study, the main activities carried out within the framework of the CE by businesses are considered. Repairing, reusing, refurbishing, reconditioning and recycling [102] are also taken into consideration because they are related to the CE.

Academics mostly address the measurement of the CE from the perspectives of resource scarcity if the research topic is energy. Criticality of materials or resource productivity is measured from the perspective of the reduction of solid waste, and the environmental impact is taken into account if the goal is to reduce emissions or pollution [103]. Bio-based and recycled products made from renewable biological resources and/or totally recycled materials are also considered as crucial for a CE. Moreover, it has been stated that eco-innovation plays a relevant role in transforming a linear system into a circular one [34].

In order to measure the CE, the relationship between the CE and indicators applied to eco-innovation measurement has been pointed out by Smol et al. [100]. From these considerations, waste recovery, actions related to energy efficiency and renewables, and eco-design and eco-innovation have been considered as basic activities when the CE is measured.

2.3. Research Questions

To the best of our knowledge, there is a gap in the literature as the relationship between the level of investment and firms' activities within the circular model has not been studied in detail. Within the framework of the RBV, certain resources and capabilities are particularly relevant for companies to improve their competitive advantage through eco-innovation.

In summary, the RBV is applied in this study to expand the knowledge in the corporate finance field to better understand whether the amount of financial resources drives better environmental performance in terms of the CE in businesses. The definition and description of specific financial resources applied to CE is also a goal of this study and the measurement of the level of CE achieved by companies allows us to enhance the knowledge about the measurement of the circular scope at the micro level.

On this basis and following the analysis of the literature about financial resources that can be applied to the CE, the research questions proposed in this study are as follows:

R1: Does a higher level of investment mean a higher level of CE in businesses?

R2: What characteristics of financial resources are related to the level of investment in the CE?

R3: Are financing decisions about the nature of resources related to the level of investment in the CE?

R4: Which activities for environmental improvement are influencing the circular scope of companies?

This study is transversal as it falls between the bodies of the measurement of financial resources for environmental investments and the CE activities carried out at the micro level, excluding analyses at the meso and macro levels [104].

3. Method and Sample

3.1. Sample and Data Collection

The analysis was performed through surveys that were sent to companies that were collaborating with an R&D project in north-eastern Spain. Companies were selected with more than 50 employees because the size is a factor that facilitates eco-innovative processes [105–108] and it was considered as a relevant characteristic of firms for the transition from a linear model to a circular model. Additionally, companies were selected if they operate in sectors with potential engagement with the CE. For this study, those sectors related to technologies included in the "Best Available Techniques", the so called "BREFs", were considered: industrial, transport and logistics, waste, extractive industry, manufacturing industry, electricity, gas, steam and air conditioning supply; water supply, sewerage, waste management, transport and storage. In these sectors the introduction of CE principles is both, necessary and technologically feasible [109]. Finally, 87 valid answers were obtained from a population of approximately 1000 companies that were identified with their corresponding value added tax identification number (VAT number). Table 2 summarizes the profile of the sample.

Table 2. Profile of sample.

	Total Assets (thousand euros)	Total Turnover (thousand euros)	Number of Employees	Return on Assets
Means	903,181.3	298,140.3	558.1	0.063
Deviation	5,426,286	1,084,284	1700.53	0.125
Minimum	1362.613	3952.4	50	−0.39
Maximum	48,300,000	8,597,300	14,106	0.56

The sample is integrated by medium businesses (66.67% have less than 250 employees), manufacturing firms (39.08%) and firms that are operating in the energy sector (26.44%).

3.2. Measurement and Variables

Specific variables were designed to measure the level of investments and the characteristics of the financial resources applied to CE-related activities. Variables used in other studies were taken as a starting point and specific variables were also developed for this study. Table 3 provides the items of the construct elaborated from the surveyed companies for the measurement of investments related to CE activities. Company size was considered as a control variable [110].

Table 3. Constructs, items and selected variables used to measure the financial resources applied by businesses.

Construct/Items	Description
Measurement of Investment in Activities Related to the CE	
Construct: FR	**Financial Resources**
FR-Q	*Construct "FR-Q":* **Financial Resources – Quality**
FR1	Level of collateral (guarantees) required for the company to finance eco-design/eco-innovation/environmental improvements compared to that required for other investments
FR2	Level of costs of external funds for eco-design/eco-innovation/environmental improvements higher than those necessary for the company's other investments
FR-A	*Construct "FR-A":* **Financial Resources – Availability**
FR3	Level to which the capital availability of the company's financial resources determines the investments
FR4	Level to which uncertainty about the cash flows derived from the investments in eco-design/eco-innovation/environmental improvements hamper the decision-making process

Table 3. *Cont.*

Construct/Items	Description
Measurement of Investment in Activities Related to the CE	
Construct: SF	**Source of Financing**
SF1	% of investments in environmental R&D, eco-design or similar that are financed with the company's own funds ("equity funds")
Construct: FR	**Financial Resources**
SF2	% of environmental R&D investments, eco-design or similar that are financed through public funds ("public grants"— subsidies, tax deductions, incentives, bonuses, etc.)
SF3	% of environmental R&D investments that are financed through foreign funds ("foreign funds")
Construct: ICA	**Investment in Activities Related to the CE**
CER	*Construct "CER":* **Energy Valorisation and Renewables (Circular Investments)**
ICA1	% of total revenues invested in energy valorisation of waste
ICA2	% of total revenues invested in renewables
CECOi	*Construct "CECOi":* **Eco-Innovation**
ICA3	% of the company's total revenues invested in innovative equipment/machines to reduce the company's environmental impact
ICA4	% of the company's total revenues invested in environmental R&D (internal or external) for eco-innovating
Construct: S	**Size of Companies**
S1	Total assets (thousand euros)
S2	Total turnover (thousand euros)
S3	Total employees (number of employees)

Thus, the possibility to extend a system of measuring eco-innovations and combine it with CE principles offered a set of transparent and accessible indicators that have already been tested and represents a simple and quick instrument for assessing the level of CE eco-innovation in a group of industries [100]. To define the scope of CE thought the activities performed by the firms, the variables described in Table 4 were selected.

Table 4. Constructs, items and selected variables used to measure the scope in terms of CE achieved by businesses.

Construct/Items	Description
Measurement of Circular Scope	
Construct CS	**Circular Scope**
CW	*Construct "CW":* **Waste Recovery**
CW1	% of recycling waste within the company itself (treatment to be recycled)
CW2	% of waste recovery within the company and reuse
DR	*Construct "DR":* **Dematerialization and Recycled Materials**
DR1	% of resource that has been replaced by other fully recycled materials to manufacture products or to provide services
DR2	% of the products' design or services that have been modified to reduce the resource intensity
CSE	*Construct "CSE":* **Circular Eco-Design**
CSE1	% of the products' design or services that has been modified to increase their functions (multifunction)
CSE2	% of the products' design or services that has been modified to extend their durability
CSE3	% of the products' design or services that has been modified to increase their recyclability (waste prevention)
SR	*Construct "SR":* **Resource Saving and Efficiency**
SR1	% of equipment or facilities that has been replaced and/or improved to reduce energy consumption
SR2	% of processes or operating procedures that has been replaced and/or improved to reduce energy consumption or to exploit renewables
SR3	% of components of the product or service that has been replaced by innovative components to comply with environmental regulations

In summary, variables were designed to measure the savings in emissions and resources, the replacement of raw materials and components and the investments made to decrease the environmental impact of products and companies, eco-design for the CE, waste valorisation and other related variables.

3.3. Statistical Analysis

To test the research questions, we used PLS-SEM. Our objectives were to predict the CE level of activity carried out by a company in the framework of the RBV to identify the key drivers that explain the specific characteristics of those funds invested in CE-related activities to make a firm more circular. PLS is recommended when the research objective has predictive purposes [111–114] and explanatory purposes [115]. Moreover, the use of PLS-SEM is also recommended when the research is trying to identify the key target constructs [116]. The application of a multiple indicators and multiple causes (MIMIC) approach in CB-SEM could mean constraints on the model that often contradict the theoretical assumptions. This conceptualisation and these conditions have been found in our model. We applied this statistical approach since it enabled us to estimate a complex model with many constructs, indicator variables and structural paths without imposing restrictions on distributional assumptions and size on data [117].

The PLS-SEM method is currently being subjected to debate about its pros and cons. The main criticisms of this methodology have been summarised by Rönkkö and Evermann [118] and Rönkkö et al. [119]. These authors argue that the use of PLS weights and many rules of thumb that are commonly employed with PLS are unjustifiable. In responses to the criticisms, different improvements and extensions to the method have been introduced by some authors [120,121]. Hair et al. 2018 [117] and Petter [122] recently demonstrate the value of PLS as an SEM technique. Currently, this method is widely applied by academics in the environmental innovation field [123–125].

PLS can be used with small sample sizes [117]; however, the nature of the population also determines the situations in which small sample sizes are acceptable [117,126]. Kock and Hadaya [127] demonstrate that the power of PLS-SEM is consistent with what one would expect from ordinary least squares regression and probably from other methods with similar mathematical underpinnings. Thus, in this study, the recommendations of Kock and Hadaya [127] are also taken into account to evaluate the minimum sample size estimation that is required for PLS. The method known as the "minimum R-squared method", proposed by Hair et al. [128], that builds on Cohen's [129] power tables for least squares regression, has been applied in our study. Taking into account the values reached in our model for three elements—the maximum number of arrows pointing at a latent variable, the significance level and the minimum R2 in the model—we confirm that the data available in this research are sufficient to perform PLS properly.

The empirical study was carried out in two phases. In the first phase, an exploratory factor analysis was performed to validate the composite variables obtained from the indicators (i.e., the measurement scales). In the second phase, both the measurement model and the structural model were assessed. To this end, the SmartPLS 3.0 software (SmartPLS GmbH, Bönningstedt, Germany) was used as it is less sensitive to the violation of assumptions of data normality [130,131]. Moreover, we assessed the predictive validity of the structural model through the PLSpredict technique [112].

4. Main Results and Discussion

As a main result of this study, it was found that the level of investments carried out by companies was related to their scope of CE. To describe the activities carried out by businesses, it was observed that the level of innovative component replacement to comply with environmental regulations ranged from 1 to 10% of the incomes of the surveyed companies. Likewise, the respondents indicated a level investment in environmental R&D, eco-innovation, eco-design or similar that ranged between 1 and 10% of their revenues. In terms of investments in new equipment, appliances and machinery to reduce the environmental impact of the company as a whole, the average levels ranged from 6 to 10%. Average values for investments in waste valorisation and renewables ranged from 1 to 10% of the total revenues.

From another perspective, investments in eco-innovation, eco-design or similar that were financed with own funds, public incentives (subsidies, tax deductions, bonuses, etc.) and foreign funds had an average score that ranged from 6 to 10%, 1% to 5% and from 1 to 5% (and less than 1%), respectively. In Table 5, it can be observed that a high percentage of companies (26.44%) had financed more than 20% of these investments (environmental R&D investments, eco-design or similar) with their own funds, while 5.75% of companies had done so with public subsidies and 9.20% of companies with foreign funds.

Table 5. Financial resources mostly used to finance environmental investments by companies.

	More than 20% of own fund	More than 20% of public subsidies	More than 20% of foreign funds
Percentage of companies	26.44%	5.75%	9.20%

In this study, we did not differentiate the nature of these funds since the objective was to know whether companies received non-local funds or not, regardless of their nature. However, it was observed that 42.5% of the companies had foreign capital to finance their business activities. In more than 90% of these companies, the participation of foreign capital exceeded 20% of the capital. However, only 9.20% of the companies used more than 20% of foreign funds to finance their investments in environmental R&D, eco-design or similar.

The origin of subsidies and the purposes of this type of funds are summarised in Table 6.

Table 6. Origin and purpose of the public subsidies mostly used to finance environmental investments by companies.

Origin of subsidies	*% of companies with public subsidies from different financing agents*	Purpose of subsidies	*% of companies with public subsidies for different purposes*
Local Administration	**2.90%**	Employment	**14.49%**
Regional Administration	**36.23%**	R&D and innovation	**23.18%**
National Government	**39.13%**	Foreign trade	**11.59%**
European Union	**2.90%**	Environmental issues	**21.74%**
Other	**18.84%**	Other	**18.84%**

Regarding the scope of the CE achieved by the surveyed companies, the percentage of resources that were substituted ranged from 6 to 10%. The percentage of modified products to reduce resource intensity ranged from 1% to 5%. Internal waste recycling undertaken by the companies also ranged from 1 to 5% of the total volume of waste. Eco-design performed to improve the multifunctioning of products, their durability and recyclability of the products/services had an average level from 6 to 10% of the total production. In terms of resource saving, 10 to 20% of improved equipment or facilities were installed to reduce energy consumption. The percentage of improvement processes to reduce energy consumption or to exploit renewable sources ranged from 1 to 10%.

The characteristics of the financial resources applied to activities related to the CE had average scores of between 2 and 3 on a six-point scale that was used for the measurement of these variables in the questionnaire (0–"in no measure" to 5–"in large measure"). The respondents' perceptions about the extent to which the collateral (guarantees) and the cost of external financing to support eco-innovation activities were higher than for other activities reached values of 2.1 and 1.8, respectively, suggesting that these guarantees influenced eco-innovation activities. The availability of financial resources and uncertainty about the cash flows supporting the implementation of eco-innovation also greatly influenced the development of eco-innovation (the average scores achieved were 3.0 and 2.7, respectively).

4.1. Assessment of the Structural Model

As a preliminary stage to the assessment of the structural model, we carried out an exploratory factorial analysis (EFA) to test the unidimensional factors comprising the measurement scales. Results from the EFA showed that for the scales of financial resource quality (FR-Q), financial resource availability (FR-A), source of financing (SF), energy valorisation of waste and renewables circular investments (CER), eco-innovation (CECOi), waste recovery (CW), dematerialization and recycled materials (DR), circular eco-design (CSE), resource saving and efficiency (SR) and size of companies (S) were all formed by a single factor with a high explained variance: FR-Q = 82.07% (Kaiser-Meyer-Olkin (KMO) = 0.5), FR-A = 60.18% (KMO = 0.5), SF = 88.8% (KMO = 0.52), CER = 63.53% (KMO = 0.5), CECOi = 68.02% (KMO = 0.5), CW = 81.5% (KMO = 0.5), DR = 57.62% (KMO = 0.5), CSE = 61.4% (KMO = 0.56), SR = 57.3% (KMO = 0.5), and S = 68.74% (KMO = 0.51). For all scales, the KMO index provided good results, and the Bartlett's sphericity tests reflected a significance level of less than 0.001. These results show the appropriateness of the exploratory factor analysis performed.

In a second stage, the structural model was assessed. Figure 1 shows the results of PLS analysis. First, variables were combined as weighted sums (composites). In this way, aggregate measures were generating as they can be expected to be more reliable than any other indicator. Consequently, we used them as proxies for the following constructs: FR-Q, FR-A, SF, CER, CECOi, CW, DR, CSE, SR and S. The quality of this measurement model was assessed by analyzing the construct's reliability, the convergent validity criterion and the discriminant validity. Then, the cause–effect relationship between the variables was analysed. The effects from the exogenous variables on the endogenous variables and the statistical significance of the relationships between the variables are shown in Figure 1. Below, we detail and explain the results of the analysis, differentiating both the assessment of the measurement model and the assessment of the structural model.

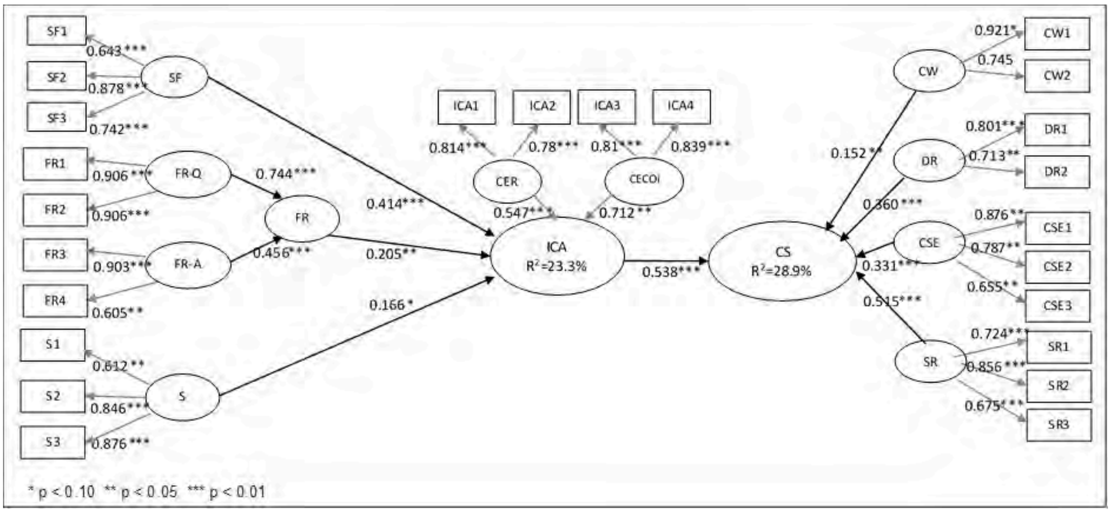

Figure 1. Structural model results.

With regard to the assessment of the measurement model, Table 7 shows the variables' standardized loadings. For all of the variables, standardized loadings were greater than 0.7 and were thus found to be significant. These results ensured the adequacy of the selected indicators. The consistency of the indicators that formed each factor was ensured by examining the composite reliability index. In all cases this index achieved very high values, being higher than 0.7, and in some cases near to or higher than 0.8 (Table 8).

The convergent validity criterion was met; in other words, all constructs had an average variance extracted (AVE) higher than 0.5 (Table 8). The minimum value recommended is 0.5 [132], which means that over 50% of the construct variance was due to its indicators. Discriminant validity was tested by examining two criteria. First, the matrix of loadings and cross-loadings was examined. The model loadings were larger than the cross loadings (see Table 7), then the criterion was fulfilled. The second criterion was also met, as the square root of the AVE of each construct was larger than the correlations among constructs (see Table 8).

Regarding the assessment of the structural model, Figure 1 and Table 9 show the overall model results, namely, the explained variance (R2) of the dependent variables, the path coefficients, and the significance of the paths. The significance of the path coefficients was tested using a bootstrap resampling procedure with 5000 iterations [133].

Table 7. Outer model loadings and cross-loadings.

	CER	**CECOi**	**FR-Q**	**FR-A**	**SF**	**CW**	**DR**	**CSE**	**SR**	**S**
ICA1	0.814	0.214	0.129	0.166	0.169	0.134	0.175	−0.075	0.284	0.185
ICA2	0.78	0.174	0.289	−0.002	0.104	−0.088	0.168	0.032	0.262	0.332
ICA3	0.178	0.81	0.084	−0.138	0.184	0.104	0.491	0.244	0.545	−0.041
ICA4	0.223	0.839	0.187	−0.017	0.499	0.164	0.353	0.072	0.379	0.058
FR1	0.223	0.152	0.906	0.317	−0.23	−0.147	0.179	0.06	0.025	0.043
FR2	0.245	0.149	0.906	0.319	0.064	−0.09	0.121	0.025	0.067	0.104
FR3	0.033	−0.046	0.367	0.903	0.037	0.004	0.286	0.102	0.062	0.13
FR4	0.182	−0.123	0.119	0.605	−0.084	−0.071	−0.042	−0.29	−0.115	0.193
SF1	−0.01	0.356	−0.162	−0.059	0.643	0.175	0.145	0.051	0.208	−0.167
SF2	0.215	0.33	−0.065	0.006	0.878	0.244	0.238	0.063	0.41	0.061
SF3	0.127	0.186	0.051	0.042	0.742	0.15	0.107	0.145	0.417	0.037
CW1	0.082	0.158	−0.14	−0.041	0.28	0.921	0.142	0.073	0.211	−0.059
CW2	−0.061	0.109	−0.064	0.006	0.166	0.745	0.133	−0.078	0.104	−0.107
DR1	0.245	0.519	0.046	0.181	0.243	0.1	0.801	0.047	0.675	0.332
DR2	0.069	0.232	0.22	0.142	0.123	0.15	0.713	0.544	0.242	−0.08
CSE1	−0.08	0.131	−0.03	−0.02	0.07	0.093	0.372	0.876	0.237	−0.172
CSE2	−0.066	0.052	0.083	0.025	−0.036	−0.08	0.192	0.787	0.108	−0.092
CSE3	0.079	0.239	0.08	−0.1	0.207	−0.001	0.244	0.655	0.291	−0.021
SR1	0.048	0.319	−0.026	−0.118	0.446	0.188	0.21	0.399	0.724	−0.197
SR2	0.46	0.407	0.087	−0.076	0.422	0.169	0.371	0.214	0.856	0.122
SR3	0.245	0.519	0.046	0.181	0.243	0.1	0.801	0.047	0.675	0.332
S1	0.278	−0.049	−0.046	−0.04	−0.031	−0.058	0.028	−0.061	0.12	0.612
S2	0.2	0.008	0.114	0.176	−0.037	−0.075	0.282	−0.083	0.174	0.846
S3	0.273	0.049	0.104	0.258	0.005	−0.076	0.142	−0.141	0.044	0.876

Table 8. Construct reliability, convergent validity and discriminant validity.

	CER	**CECOi**	**FR-Q**	**FR-A**	**SF**	**CW**	**DR**	**CSE**	**SR**	**S**	**Composite Reliability**	**AVE**
CER	0.797										0.777	0.635
CECOi	0.244	0.825									0.809	0.680
FR-Q	0.258	0.167	0.906								0.902	0.821
FR-A	0.107	−0.091	0.351	0.768							0.735	0.590
SF	0.173	0.421	0.091	0.007	0.715						0.748	0.512
CW	0.034	0.164	0.131	0.028	0.278	0.838					0.823	0.702
DR	0.215	0.508	0.166	0.214	0.247	0.162	0.759				0.730	0.576
CSE	−0.03	0.188	0.047	0.044	0.112	0.021	0.362	0.778			0.819	0.605
SR	0.343	0.556	0.05	0.001	0.488	0.201	0.625	0.283	0.755		0.798	0.571
S	0.321	0.013	0.081	0.19	0.021	0.089	0.187	0.129	0.128	0.787	0.827	0.619

Table 9. Structural model results.

Relations	Path Coefficients	t-value	Percentile Bootstrap 95% Confidence Level	
			Lower	Upper
CW => CS	0.152 **	2.043	0.027	0.310
DR => CS	0.360 ***	9.420	0.302	0.460
CSE => CS	0.331 ***	3.227	0.109	0.476
SR => CS	0.515 ***	9.696	0.430	0.620
ICA => CS	0.538 ***	7.789	0.383	0.658
CER => ICA	0.547 ***	6.002	0.363	0.727
CECOi => ICA	0.712 ***	8.487	0.579	0.918
SF => ICA	0.414 ***	4.202	0.196	0.591
FR => ICA	0.205 **	2.081	0.004	0.362
FR-Q => FR	0.744 ***	12.347	0.654	0.906
FR-A => FR	0.456 ***	8.097	0.353	0.548
S => ICA	0.165 *	1.796	0.019	0.342
Variances explained R2	$R2_{ICA}$ = 23.3%, $R2_{CS}$ = 28.9%			
Stone-Geisser's Q2	$Q2_{ICA}$ = 0.168, $Q2_{CS}$ = 0.269			

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

Empirical support was found for all of the cause–effect relationships proposed in the research questions (Figure 1 and Table 9). Specifically, the construct we term investment in activities related to CE was positively related with the circular scope of businesses. These results suggest empirical support for the first research question (R1). Likewise, investment in activities related to CE, explained by energy valorisation of waste, renewable energy investments and eco-innovation, was positively related with the characteristics of the financial resources applied to the activities, including their quality and availability, the source of financing and the company's size. These results allowed us to respond to the second research question (R2) and suggest that all characteristics of financial resources were related to the level of investment in the CE. In particular, the construct named financial resources quality (FR-Q) explained 67% of the variance of the construct FR (Table 10).

Table 10. Effects on endogenous variables.

Relations	Direct Effects	Correlation	Variance Explained
SF => ICA	0.414	0.397	0.16
FR => ICA	0.205	0.192	0.04
S => ICA	0.165	0.186	0.03
FR-Q => FR	0.744	0.904	0.67
FR-A => FR	0.456	0.717	0.33
CW => CS	0.152	0.321	0.05
DR => CS	0.360	0.829	0.30
CSE => CS	0.331	0.612	0.20
SR => CS	0.515	0.868	0.45
ICA => CS	0.538	0.538	0.29
CER => ICA	0.547	0.722	0.39
CECOi => ICA	0.712	0.825	0.59
Variances explained R2	$R2_{ICA}$ = 23.3%, $R2_{CS}$ = 28.9%		

The results also allow us answer research question R3 in the affirmative, since the construct named source of financing was related to level of investment in the CE, especially the decision about financing through public subsidies (0.88). As shown in Table 10, the construct named financing resource contributed the highest percentage (16%) to the explained variance of the investment in activities related to CE.

Regarding research question R4, Table 8 shows that empirical support was also found for the positive relationship of the circular scope of businesses, summarised with the activities related to waste recovery, dematerialisation and recycled materials, circular eco-design and resource saving and efficiency. The construct named resource saving and efficiency contributed the highest percentage (45%) to the explained variance of the circular scope (Table 9). Empirical support was not found for the relationship between the size of company and the investment in activities related to CE.

The variance of the dependent variables was high: 23.3% and 28.9% for the investment in activities related to the CE and the circular scope, respectively (see Figure 1 and Table 8). The model was highly predictive of the investment in activities related to the CE and the circular scope. The values of Stone Geisser's cross-validated redundancy (Q2 = 0.16 for the investment in activities related to CE, and Q2 = 0.26 for the circular scope) confirmed the structural model's predictive relevance (Q2 > 0). The approach and recommendations of Shmueli et al. [112] were applied for assessing the predictive validity of the model. For this one, we used PLSpredict and carried out the benchmark procedures developed by the SmartPLS team [134]. Table 11 shows Q2 values, which compared the prediction errors of PLS results against simple mean predictions. All Q2 values (Q2 > 0) confirmed that the prediction error of the PLS results was smaller than the prediction error of simply using the mean values. Moreover, the differences between PLS and LM results (named differences PLS-LM) were very small for all indices: Q2, mean absolute error (MAE) and the root-mean-square error (RMSE). The Q2 differences were less than 0.06 in all cases, and the MAE differences and RMSE differences were around 0.03 and lower. Thus, the predictive validity of the model was confirmed.

Table 11. Partial least square (PLS) prediction assessment.

Indicator Prediction Summary									
	PLS			LM			Differences PLS-LM		
	RMSE	MAE	Q2	RMSE	MAE	Q2	RMSE	MAE	Q2
CW	1.006	0.609	0.01	1.03	0.618	0.037	−0.024	−0.009	−0.027
DR	0.956	0.713	0.107	0.975	0.725	0.073	−0.019	−0.012	0.034
CSE	1.015	0.757	0.004	1.041	0.783	0.054	−0.026	−0.026	−0.050
SR	0.918	0.699	0.182	0.913	0.690	0.19	0.005	0.009	−0.008
CER	0.972	0.685	0.076	0.966	0.682	0.086	0.006	0.003	0.001
CECOi	0.952	0.687	0.116	0.947	0.677	0.125	0.005	0.01	−0.009
Construct prediction summary									
CS	Q2 CS = 0.145								
ICA	Q2 ICA = 0.184								

4.2. Discussion and Implications on CE

In this paper, we have addressed certain characteristics of financial resources that can influence the circular activities developed by firms in the RBV framework to explain the relevance of specific resources of businesses in the transition towards the circular model. Based on the literature reviewed in this paper, which takes a theoretical approach to firms' financial resources, we have made progress in the knowledge of the management of the endogenous factors that are applied by businesses in the processes of the CE.

From the obtained results, we can affirm that the level of investment is related to the scope of CE achieved by companies (R1). These results allow us to make inferences in a line of inquiry that is, thus far, little explored due to the initial stage of the CE activities implemented by the companies. To the best of our knowledge, similar studies do not currently exist that could be discussed.

The availability of funds and, in particular, the quality of financial resources, are also related to the level of investment in the CE. The availability of resources, especially at an adequate cost, are shown as relevant factors in the development of diverse circular activities carried out by companies. In particular, the quality of resources should be noted as the level of collateral (guarantees) required for a company to finance activities in the framework of CE was higher than the level required for other investments. A similar observation was made with respect to the higher level of costs of the external funds required for these activities (R2). Thus, the obtained results endorse and expand the studies that identify the quantity and availability of financial resources as one of the barriers to the CE [31,37,44].

Another line of research concerns the relevance of the financing decisions on the nature of resources (R3). The results obtained in this study bear out the role of public funds and subsidies as drivers to the promotion of the CE [44,45]. The lack of financial resources is also considered as a barrier for eco-innovation [68]. Likewise, the availability of public funds (subsidies) to finance environmental R&D investments also affects the level of CE activities implemented by firms. These results are in line with the conclusions gathered in studies focused on eco-innovation [18]. Public incentives and the availability of financial resources and their quality influence a higher level of eco-innovation.

In the same line of enquiry, Cecere et al. [68] identify access to public funds and tax incentives as elements that propel the development of eco-innovation. In the CE, Ormazabal et al. [31] state that a lack of financial resources is a barrier that limits the implementation of the CE in companies and highlight the need to have public institutional support for Spanish SMEs that require different strategies, namely, financial stimulation and technological modernization, both of which are connected to the lack of financial resources. More specifically, for eco-innovation, Scarpellini at al. [18] demonstrate with a specific analysis of this sample that the availability and quality of financial resources and public incentives lead to a higher level of eco-innovation in order to define and measure different financial resources within the RBV framework.

The results of this study also suggest that access to public funds and fiscal incentives may accelerate the development of eco-innovations, and that their effectiveness interacts, in particular, with firms' availability of external financing, in line with Cecere et al. [68]. Empirical results regarding the effectiveness of subsidies (and tax incentives) to promote eco-innovation are not absolutely conclusive [135,136], although some authors show that public subsidies drive the development of eco-innovations [92,137–140]. From our analysis, the relationship between the CE and indicators applied for eco-innovation measurement pointed out by Smol et al. [100] is endorsed.

5. Conclusions

The different characteristics of financial resources applied to circular activities by firms have been analysed in this study to enhance the knowledge about the influence of businesses' financial resources to achieve a more advanced level of CE. Public subsidies and the availability and quality of finance applied by firms to circular activities have been measured using a novel approach in the framework of the RBV. These characteristics of financial resources influence the activity's development and determine the choice of resources to finance the investments. The importance of public financial incentives has also been demonstrated, as it allows a reduction in risk exposure, the financial feasibility and the provision of profitability of the CE investment projects.

Although it cannot be conclusively demonstrated that the CE requires exclusive resources, we observed that some resources that are applied by businesses to investments related to the CE, such as the improvement of the environmental performance, eco-innovation, eco-design, resource valorisation, energy efficiency or renewables, can be differentiated from those applied to other processes by companies.

In summary, this paper represents an expansion of the previous literature by increasing the knowledge about financial resources as one of the barriers to the CE. Additionally, the relevance of the financing decisions to the nature of financial resources has also been analysed, which is a novelty in this field. The results obtained in this study bear out the role of public funds and subsidies as drivers for the promotion of the CE, and can be applied by public administrations to promote circular businesses.

The measurement of different activities carried out by firms that are related to the circular model provides a preliminary outlook for progress towards the CE in businesses. Activities that are influencing the circular scope of companies have been defined. These results launch a double line of enquiry about the measurement of the circular scope of businesses, from one side, and the specific investments that must be applied to the CE as unique and inimitable resources of each company in the framework of the RBV, from another side.

In the academic field, this study offers innovative results in the corporate finance framework for the management of financial resources. In the environmental management accounting field, this study offers specific knowledge for measuring CE activities and processes. For practitioners, the obtained results provide a set of indicators for CE measurement at the industry level, allowing companies a means of transparency and reporting on their activity, corporate social responsibility related to the CE, and environmental performance in closing the production loops.

A limitation of this study is related to the measurement of the degree of circularity, which only accounts for some of the activities carried out by businesses. The use of other indicators that also reflect materials embodied in trade could provide an additional perspective. However, this study does not provide a detailed analysis of the relationship between financial resources and financial performance. The role of venture capital operations or business-angels' funds and the role they can play in the development of investments in the CE are also not addressed in this paper since this would require more in-depth analysis taking into account a larger set of indicators.

Furthermore, it is important to also investigate trends in progress made over a longer period in order to obtain longitudinal data relating to current development trends in the CE. Reliable and relevant data are essential in order to monitor progress towards a circular economy and to analyse the role of eco-innovation in this process.

The obtained results are relevant for the internal measurement processes related to the CE.

One of the challenges for academics is to bring the discussion around the CE to the firm level. In our case, the contribution to the debate about what resources are being applied by businesses to close the loops to be more competitive in this new business model has been focused on those financial resources that are needed to invest in circular innovative solutions.

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