UNIVERSITÀ CATTOLICA del Sacro Cuore

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Abstract

This study investigates the relationship between Firms' Performance and the adoption of a Circular Economy (CE) Approach. Considering different "recovery-recycling" models embraced by European countries between 2003 and 2016, the empirical analysis aims to highlight benefits related to CE approach. Specifically, we built a sample of *panel data*, which involved 60 European listed companies producing several types of packaging (including plastic, glass, cardboard and metal), and raw materials (glass and paper). Over the last decades, the increasing attention to Circular Economy issues in Europe has been followed by an important regulation's activity aimed to define a common policy on the production and treatment of waste. However, European countries due to their different economic conditions, experienced more or less effectively benefits of CE models which are still under-explored. Our empirical findings confirm previous economic literature (Ferreira N. et al. 2014; CIWM, 2016), pointing out better Perfomances for European companies adopting "Extended Producer Responsability" (ERP) scheme, such as PRO's Competition model. Empirical evidences suggested a positive and highly significant impact on Firms' Performance as results of more competition among recovery organizations which can be justified by lower costs for companies joining collective recovery schemes.

Keywords: Circular Economy, Firms' Perfomance, Extended Producer Responsability (ERP), Stock Return.

JEL Classification: C23, Q01, Q56

1. Introduction

The growing interest in sustainability issues has led many companies to rethink the way they operate. During the last decades, both academic and pratictioners have prompted a wide debate about companies' business model, highlighting the relevaance to adopt a more sustainable approach.
The traditional linear model of "*take-make-use-dispose*" of materials and energy flow which has dominated development over the years, has been the cause of serious environmental damage, proving to be unsustainable (Frosch and Gallopoulos, 1989). For this reason increasing attention has been devoted to devolop a new model ideally capable of reducing resource waste and pollution as well.

Circular economy (CE) is currently concept promoted by the EU, by several national governments and by many businesses around the world (Korhonen J, Honkasalo A. and Seppälä J 2018). Through the use of renewable reources, CE entails a continue regeneration of the economic system. According to this model, all the waste of productive processes, should be treated, recycled, reconditioned in order to become *input* of new processes triggering a more efficient mechanism of production.

Numerous academic studies show that the transition to a CE model tends to determine not only Environmental and Social benefits, but it is capable to generate potential economic benefits quantified in thousands of billions of euro[1] as well. Among the areas of greatest interest, a prominent position is held by the issues of recycling and recovery of waste. In order to guarantee the continuos circularity of resources, it is essential to recover and reuse waste from production or consumption limiting the use of virgin materials. In this context, the effectiveness implementation of recovery models gives to the companies the opportunity to achieve relevant positive results such as access to flows of secondary raw materials at competitive prices, the possibility to eliminate continuosly unwanted industrial waste at advantageous economic conditions, potential synergies arising from the use of waste from some industrial areas as input for other. However, CE is still widely unexplored from an empirical point of view.

Using a sample of European listed companies between 2003 and 2016, we aim to analyze the potential interactions between CE models and Firms' Performance. This reasearch work aims to empirically point out the existence of economic benefits related to the adoption of a circular approach. According to the economic literature, we consider a parsimonious set of variables which involves variables generally used to estimate Stock Returns, and other hand dummies related to Circular Economy issues. In order to study the main difference between the linear traditional system and CE model, special attention will be devoted to a particulary tool introduced by EU Directives namely "Extended Producer Responsibility" (ERP).

2. The transition to a circular approach

The traditional economic system, wich considers a linear approach, although particularly effective in matching supply and demand, is no longer sustainable. The linear model is mainly summarized in three phases: "*take,*

[1] The global economy would benefit 1000 billion US dollars annually (Ellen MacArthur Foundation and Mckinsey, 2014).

produce and dispose". According to this approach, the natural resources represent the inputs for the production of goods and services, whose life cycle, once consumed, ends in disposal, creating waste and refuse. However, natural resources, by definition scarce and finite (Meadows et al., 1972), will not be able to support a linear economic system. Many studies in literature show that this system, based on an ever-increasing consumption of non-renewable resources, is unsustainable in the long-term (Frosch and Gallopoulos, 1989).

In the traditional economic context, the wealth of materials and low supply costs have led to low productivity of the resources themselves, enormous waste and scarce interest in social and environmental issues. Major issues (Lacy, Rutqvist, and Lamonica, 2016) can be traced into the following types of "waste":

1) Waste of resources: due to the use of non-renewable and polluting energy and materials;

2) Life cycle waste: related to the "*take-make-use-dispose*" model, whereby obsolete or broken products are discarded before their life cycle is actually over;

3) Capacity waste: wich highlights the ineffcient use by consumers of many goods that could instead be shared with other consumers;

4) Waste of valuable components: wich consists of the loss of value components, which, in a linear model, are wasted and destined to disposal.

In this context, among the other main factors that have a direct and indirect negative impact, the growth of population is really significant. The relevant population increase observed in the last 50 years[2] has pointed out two main problems: an increase in demand for non-renewable resources (between 1960 and 2014, Accenture estimated an increase in resources' consumption of 450%)[3], and a direct effect on the growth of waste[4]. However, the growing use of resources seems to impact by environmental point of view and economical as well[5]. The worrying environmental and economic data observed over the decades have prompted many scholars and practitioners to seek more sustainable economic models. In 1989 for the first time, Pearce and Tuner proposed the "circular" approach. The two authors argue that the best alternative choiche to the linear model, in which the life-cycle of a good/product generally ends with its consumption, is represented by the transition to a new economic system based on the "circularity" of resources.

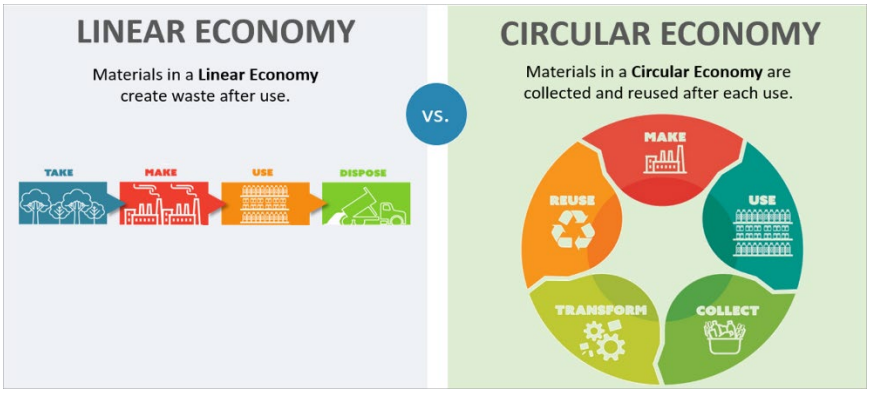
According to the definition proposed by Ellen MacArthur Foundation, which was created to promote the development of the circular model, the Circular Economy (CE) consists to:

[2] Over the past 50 years, the worldwide population has grown from 3.031 billion in 1960 to 7.674 billion in 2019 (https://data.worldbank.org/indicator/SP.POP.TOTL - updated to 15/06/2021).
[3] Lacy P., Rutqvist J. and Lamonica B. (2016).
[4] Bank of America shows that in 2013 11 billion tons of waste were generated, of which only 25% was recovered coming into the production system, with huge differences between OECD and developing countries (https://www.longfinance.net/media/documents/baml_waste_2013.pdf - updated to 15/06/2021).
[5] According to some estimates by Accenture, due to low recovery and recycling rates, waste represents annual value losses in the range of $1 trillion.

"*an economy designed to be able to regenerate itself, in which material flows are of two types: biological ones, able to be reintegrated into the biosphere, and technical ones, destined to be revalued without entering the biosphere*"[6].

In the "biological" cycle, resources are continuously regenerated without producing waste, while in the "technical" cycle (at the end of its cycle), resources are recovered or recycled. The circular model, therefore, has the main objective of overcoming the limits arising from the lack of resources, characterizing itself as a more virtuous and sustainable economic system than the traditional model. According to this model, all economic functions are structured with the aim to use the waste of activity as *input* for another. Figure 1 shows the traditional linear model and the circular model.

FIG.1 – "Linear" approach vs. "Circular" Approach



Source: Hi-con.com

Therefore, the use of a circular model allows to solve the aforementionated problems associated with the linear model through: i) moving to renewable inputs, materials, chemicals and biological raw materials; ii) producing goods that can be repaired, remanufactured and upgraded, through more efficient recovery channels, incentivizing return, simplifying the identification and subsequent reuse of the various components; iii) increasing the sharing, co-ownership, co-use and pooling of resources; and finally, iv) ensuring greater efficiency of the overall resources that enter the production cycle.

However, circular approach can be adopted only if it generates benefits for both consumers and producers. Consumers should not be in the condition to bear economic and operational costs higher than those of the linear model, while producers, should not incur losses at the income level.

The economic literature provides a wide variety of studies which highlight the opportunity to achieving a circular benefit without giving up profits and growth opportunities (Yong, 2007; MacArthur, 2013; Stahel, 2016; Lacy, Rutqvist and Lamonica, 2016; Prieto-Sandoval et al., 2018; Morseletto, 2020). Specifically, five business models have been identified (Accenture, 2015), towards both companies and entities can move in order to overcome traditional models of development and seize new opportunities:

[6] https://www.ellenmacarthurfoundation.org/circular-economy/concept - updated to 15/06/2021.

1) Circular Supply Chain;

2) Recovery and Recycling;

3) Product life extension;

4) Product as a service;

5) Sharing platform.

The circular supply chain model provides access to fully renewable, recyclable and biodegradable inputs to replace those typically used in the traditional linear model. Ideally, a circular supply chain is perfectly regenerative, not produce toxic waste, not require non-renewable inputs to fuel itself, and provides both economically and environmentally a more efficient use of resources than the traditional model (McDonough and Braungart, 2002).

The recovery and recycling model is the one that is most easily and traditionally linked to the concept of circular economy. This model permits to recover and recycle products, waste or refuse that have reached the end of their traditional economic cycle, avoiding the waste of significant resources whose economic life cycle should not be considered concluded. Companies which generally implement these business model can achieve numerous benefits, both in terms of lower costs related to a better compliance and waste management, greater quality materials at lower prices than "virgin" alternatives, providing different alternatives for consumers to dispose of products, as well as and increase of revenues from the sale of unwanted outputs (Lacy, Rutqvist, and Lamonica, 2016).

The "product life extension" model is a solution to the linear "buy-it-or-lose-it" model. The main objective of this business model is to maximize the life cycle of economic resources by designing products that last over the time and generally seeking to extract more value from each individual component of the product. In a context characterized by increasingly high targets in terms of sales volumes, the recent economic literature has proposed several approaches consistent with the purpose of the model in favor of producers and consumers (Systemiq and Ellen MacArthur, 2017):

- at the producer level, it is necessary to rethink the entire product life cycle with the aim of ensuring that the product can be repaired, replaced, upgraded at a fair price, or reconditioned by the same producer;

- at the consumer level, on the other hand, it is necessary to ensure that the consumer can "get rid" of obsolete or unwanted products by selling them to third parties or returning them to the producer.

The "product as a service" model, on the other hand, is closely related to the concept of "possession". Today, an increasing number of products are "sold" to the consumer without ownership transfer, as happens with bike sharing or car sharing services. The choice of this business model means that the consumer will no longer have the incentive to pay for the possession of a good, but only to have access to the functions or services provided;

while the producer will maintain possession of the final product and will generate revenues by selling services that his product is able to provide to customers (Tukker, 2004). The main purpose of this model is therefore to achieve the transition to an economy of services. This choice allows consumers to save in terms of costs, due the access to desired services through a fee payment or a subscription, and an optimization of products continuosly maintened and eventually recovered without particular difficulty by the same producer. In fact, the producer bears all the costs normally associated to the owner, and consequently, in order to be able to generate higher profits, he will be incentivized to minimize waste by optimizing the use of resources. From this perspective, this model goes hand-in-hand with the product life extension model.

The model "platform of sharing", attempts to reduce to the minimum the waste given by the unuse or inefficient use of goods, allowing to exploit to the full their economic potential. This model is based on the sharing concept and it is closely connected to the "*sharing economy*"[7].

It is possible to distinguish the concept of sharing considering the purpose of sharing: the circular approach attempts to avoid inefficient use of resources, while according to a sharing economy perspective, sharing is closely linked to concepts such as community and social cooperation (Lacy, Rutqvist, Lamonica, 2016). Therefore, it seems that an increasing number of users are intersted to share and/or using goods and resources shared by third parties. By the time, when the final consumer decides not to use a product anymore, they are sure to have extracted all the economic potential from it. As pointed out by Botsman and Rogers (2010) the profits generated through the use of such sharing systems between users have already reached considerable figures worldwide.

Among the models mentionated, this research work will focus on the recovery and recycling model. The main reason why we have chosen to consider only this model is given by the greater weight that the issues related to the recovery and recycling of materials have covered in the agendas of legislators. The importance of issues related to recycling and the creation of efficient waste flow management models is now established worldwide. At European level, the issue was raised several decades ago, starting with the 1975 “Waste Directive”[8].

Haas et al., (2015), highlight that in European, it is possible to observe a significant increase in waste recovery rates between 2005 and 2015, from 45% to 51%. Considering specifically municipal solid waste, for which longer time series are made available, the change in recycling rates between 1995 and 2015 is even more marked, from just over 11% to 29%.

Therefore, before introducing the literature review on the main studies on Circular Economy (CE) and showing the empirical analysis, we intend to recall some main regulatory developments at the European level adopted until the end of the period analysis as well as 2016.

[7] New economic theory based on the sharing of products (objects, houses, cars).
[8] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A31975L0442 -updated to 15/06/2021.

3. Regulatory developments in Europe

Among European countries, issues relating to sustainable development, and in particular circular economy issues, have been wide considered over the years. In particular, European regulations have been developed on three different levels: a first general level, a second level relating to waste treatment methods, and a third level that concerns the various waste flows. However, while in some countries the development of circular models and the production of regulations has already reached more advanced stages, in others there are still no specific regulations.

Table 1 shows the most important regulatory provisions introduced until 2016.

TAB.1 - European regulatory provisions

European Regulations	**Subject matter and Scope**
Directive **2008/98** - Waste Framework Directive	This Directive lays down measures to protect the environment and human health by preventing or reducing the adverse impacts of the generation and management of waste and by reducing overall impacts of resource use and improving the efficiency of such use.
Directive **1994/62** on Packaging and Packaging Waste	This Directive aims to harmonize national measures concerning the management of packaging and packaging waste in order, on the one hand, and to ensure the functioning of the internal market and to avoid obstacles to trade and distortion and restriction of competition within the Community.
Directive **1999/31** on the Landfill of Waste	The aim of this Directive is, by way of stringent operational and technical requirements on the waste and landfills, to provide for measures, procedures and guidance to prevent or reduce as far as possible negative effects on the environment, in particular the pollution of surface water, groundwater, soil and air, and on the global environment, including the greenhouse effect, as well as any resulting risk to human health, from landfilling of waste, during the whole life-cycle of the landfill.
Directives: - **1986/278** - **1996/59** - **2000/53** - **2006/66** - **2011/65** - **2012/19**	These directives regarding specific waste streams including sewage sludge, PCBs and PCTs, batteries and accumulators, and electrical and electronic equipment.

EU Action plan for the Circular Economy	The aim of EU Plan is to ensure that the right regulatory framework is in place for the development of the circular economy in the single market, and to give clear signals to economic operators and society at large on the way forward with long term waste targets as well as a concrete, broad and ambitious set of actions, to be carried out before 2020.

Source: https://eur-lex.europa.eu/homepage.html - Authors' elaboration.

In order to provide an overview of European legislation development, three main provisions will be discussed in detail:

a) Directive 2008/98;

b) Directive 1994/62;

c) the Action Plan for the Circular Economy.

a) **Directive 2008/98**[9]

The "Waste Framework Directive", or Directive 2008/98, illustrates a general framework on waste[10]. This directive is a revision of previous directives such as Directives 75/442/EEC and 2006/12/EC. It make a list of the main definitions related to waste and the different waste management techniques, as well as some important principles which have to be incorporated in the different legislations.

With regard to the waste life-cycle, it was defined a key principle that all European country must to implement in order to establish the own "waste hierarchy"[11]. Therefore, the directive indicates an order of priority in the planning of a waste policy (prevention, preparation for reuse, recycling, other recovery and disposal), while leaving room for discretion to the various legislators, who undertake to encourage operations aimed at generating the best possible environmental result. Within the general framework, the directive also introduces some guidelines about recovery, recycling and disposal operations, setting several goals to achieved by 2020 for specific waste streams (mainly glass, paper, plastics and metals) generated by households. At the same time, with regard to waste production and disposal, the legislator points out that operations aimed to guarantee recovery and reuse of resource must to be implemented.

Finally, we want to introduce two important principles provided by European directive: the first could be summarized as: "the polluter pays". According to this principle, the costs of waste management are blamed to who produce it. The second principle well-known as the principle of "Extended Producer Responsibility" (EPR) extends producer financial responsibility to the entire life-cycle of their products. These principles

[9] Available at https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32008L0098 – updated to 15/06/2021.
[10] The main definitions used in the research work echo those in Directive 2008/98. These definitions are reported in Appendix A.
[11] According to "waste hierarchy", wastes are considered on the basis of prevention schemes and management of flows.

aimed to make producers more responsible in order to encourage the production of more eco-sustainable and recyclable products, involging the same producer in recovery/disposal processes of materials.

The last important element concerns the obligation for member states to have one or more waste management and prevention plans, which have to review every six years, and drawn up according to specific criteria provided in the directive itself.

b) **Directive 1994/62**[12]

Directive 1994/62[13], also known as "Packaging Waste", was created with the aim to harmonizing the different European legislation on packaging[14] and management of packaging waste, in order to reduce the environmental impact and ensure the proper functioning of the internal market. According to the regulations, the commitment of European countries must be oriented first and foremost towards the prevention of the formation of waste (including the some types of "extended producer responsibility" (EPR)); with regard to recovery and recycling, the directive establishes a number of mandatory targets[15] to be achieved by 2008 in all european countries, with the exception of Greece, Portugal and some "late comers", for which some waivers have been allowed over the years. It is up to the European Commission to check that the targets[16] have been achived and reserves the right to set stricter limits in the future[17].

(c) Action Plan for the Circular Economy[18]

The "European Union Action Plan for the Circular Economy" (European Commission, 2015), approved in December 2015 by the European Commission provides differents instructions which contain suggestions and legislative proposals[19] about economic production (design of more circular products and production processes), consumption, generation and waste management, emphasizing the possibility of obtaining economic benefits from the transition to a circular economy.

Specifically, the Plan is divided into six main areas:

1) The first area concerns the "stages of production". According to regulatory interventions such as "product life extension" model and the principle of "extended producer responsibility", products' design should be easily repairable, more durable, recyclable or re-conditionable.

[12]Available on https://eur-lex.europa.eu/legal-content/IT/TXT/?uri=celex%3A31994L0062 – updated to 15/06/2021.
[13]Approved in 1994 and subject to subsequent amendments in 2004, 2005, 2013, and 2015.
[14]The definition is reported in Appendix A.
[15]Minimum recycling and recovery rates for different types of materials (glass, paper, cardboard, metals, plastics, and wood).
[16]The legislation requires member countries to have effective reporting systems in place.
[17]The annexes contained in the directive, regulate in depth the requirements and criteria for the classification of the various packaging and how to report to the Union.
[18] Available at https://eur-lex.europa.eu/resource.html?uri=cellar:8a8ef5e8-99a0-11e5-b3b7-01aa75ed71a1.0012.02/DOC_1&format=PDF – updated to 15/06/201.
[19]Key legislative proposals include Directive 2008/98 and Directive 94/62.

2) The second area is about "consumption". In order to make consumers more responsible, the European Commission seeks to promote an "eco-sustainability label" which can guarantee to the final consumer to know the products environmental footprint. Therefore, it is necessary that the different countries promote concepts such as repair, upgrade or return (for recovery), which are fundamental for circular development. It is also suggested to introduce a system capable to incentivize the marketing of products with low environmental impact.

3 e 4) The third and fourth areas take in account respectively the waste management and the re-use of waste. The European Commission highlights the importance to minimize waste disposal practices as much as possible, in favor to recovery and valorization of waste. With regard to circular *inputs*, i.e. secondary raw materials, the Plan establishes a series of regulatory interventions aimed primarily to: i) ensure common quality standards for recycled materials and consequently reduce uncertainty about their characteristics; ii) promote "green" materials such as bio-plastics; and finally iii) facilitate the flow of these materials in the European market.

5) In the fifth area, the European Plan reviews the main areas of interest within the efforts of legislators should be focused. The first is “plastic sector”, for which the European Commission suggests the adoption of strategies aimed to consider issues such as recyclability (to date only 25% of plastics are recycled), biodegradability, dangerous substances, and finally the issue of marine waste. The second sector is “food waste”, for which the Commission proposes different initiatives aimed to promote sustainable development by reducing waste production in this sector. The third area of main interest is “raw materials”, which are by definition scarce and their extraction generates significant environmental damage. In order to reduce the supply of these materials, European Commission introduces initiatives to encourage recycling. The fourth sector is “production and disposal waste”, which represents (quantitatively) one of the major sources of waste in Europe[20]. The last area of particular importance is that relating to biomass and biological products.

6) Finally, the sixth area the allocation of funds to be invested in activities focused on circularity principles. The European institutions and the countries involved, working closely together, will have a role in directing investment and funding towards the most innovative projects[21].

The European Plan also considers legislative proposals which modify the existing legislation on waste[22]. The main elements contained in the revised legislation are as follows: an increase in the recovery and recycling targets previously set; the setting of a 10% limit on landfilling of municipal waste to be achieved by 2030;

[20]Although at EU level the management of this type of waste is already strongly conditioned by the binding target of recovering at least 70% of materials by 2020, the European Commission wants to implement additional measures to improve efficiency and promote circular principles.

[21] The European Commission has approved a work program called "Horizon 2020", which destines €650 million for investment in circular projects.
More details are available at https://ec.europa.eu/programmes/horizon2020/sites/default/files/H2020_inBrief_EN_FinalBAT.pdf - updated to 15/06/2021.

[22] The proposals amend Directive 2008/98 on waste, Directive 1994/62 on packaging, Directive 1999/31 on landfill storage, Directive 2000/53 on the disposal of motor vehicles, Directive 2006/66 on batteries and accumulators, and finally Directive 2012/19 on electrical and electronic waste.

measures to promote the prevention and reuse of waste (including food waste); the introduction of minimum operating conditions for the "extended producer responsibility" regime; and the introduction of economic incentives to induce producers to put "greener" products on the market while supporting recovery and recycling schemes.

The European Action Plan and Directives 2008/98 and 94/62 highlight the great effort of the European Union to overcome the limitations of the linear model through the promotion of a circular model.

This research work will try to verify the degree of implementation of the various provisions within 18 European countries, analysing policies and results obtained by national legislators by the implementation of European provisions. Table 2 lists the targets setted by directives and European Plan.

TAB.2 - Recovery and Recycling Directives and Targets

European Regulations	**Re-use and Recycling Targets**
Directive 1994/62 on Packaging and Packaging Waste	(a) no later than five years from the date by which this Directive must be implemented in national law, between 50 % as a minimum and 65 % as a maximum by weight of the packaging waste will be recovered; (b) within this general target, and with the same time limit, between 25 % as a minimum and 45 % as a maximum by weight of the totality of packaging materials contained in packaging waste will be recycled with a minimum of 15 % by weight for each packaging material; (c) no later than 10 years from the date by which this Directive must be implemented in national law, a percentage of packaging waste will be recovered and recycled, which will have to be determined by the Council in accordance with paragraph 3 (b) with a view to substantially increasing the targets mentioned in paragraphs (a) and (b).
Directive 2008/98 - Waste Framework Directive	a) by 2020, the preparing for re-use and the recycling of waste materials such as at least paper, metal, plastic and glass from households and possibly from other origins as far as these waste streams are similar to waste from households, shall be increased to a minimum of overall 50 % by weight; b) y 2020, the preparing for re-use, recycling and other material recovery, including backfilling operations using waste to substitute other materials, of non-hazardous construction and demolition waste excluding naturally occurring material defined in category 17 05 04 in the list of waste shall be increased to a minimum of 70 % by weight.
EU Action plan for the Circular Economy	a) by 2025: The pledges submitted by industry so far will increase the market for recycled plastics by at least 60%.

	b) by 2025 and 2030: target to incorporate 25% of recycled plastic in PET bottles as from 2025 and 30% in all plastic bottles as from 2030, as well as a 90% separate collection target for plastic bottles by 2029 (77% bottles by 2025) and the introduction of design requirements to connect caps to bottles.

Source: https://eur-lex.europa.eu/homepage.html - Authors' elaboration.

4. Literature review

CE is rooted on several advanced theories in the field of industrial ecology, a science which studies the different economic models and their interaction with the environment in terms of flows of materials, resources, energy and information (Erkman, 1997). Within the economic literature, the first considerations around the concept of "circularity" of the economic system and the limits of the linear system can be traced to Pearce and Turner (1989), now recognized as the fathers of CE. Starting from the findings of this study, the following ones in economic literature have highlighted the existence of a relationship between the economic and environmental processes (Ghisellini et al., 2016; Charonis, 2012; Xia and Yang, 2007).

In this context, a first strand of literature has focused on the study of a set of indicators capable to assess the effective implementation and development of CE practices. These indicators have been distinguished on three levels: i) at the *micro-level*, analyzing the adoption of circular models by firms; ii) at the *macro-level*, considering policies and performance in terms of circular economy at the national and intenational level; and finally, iii) at the *intermediate* level with respect to the previous two, shifting the focus to cities or macro-areas.

A large number of studies (especially at the micro-level) have focused on China (Hesmati, 2015)[23]. However, over the years many countries have developed and implemented Circular Economy models, although they followed significantly different paths and achieve different results.

Micro-level studies have proposed indicators linked to productivity measures in order to investigate whether the development of a circular model could lead to better business performance in terms of greater efficiency in the use of resources and materials. Du and Cheng (2009), considering the Chinese industrial context have built nine indicators of input and output, and a productivity index. By using this productivity index into an analysis of production efficiency based on the *Data Envelopment Analysis*[24] method, they point out a positive trend related to an increase in technological efficiency. Considering Chinese firms, Zhou and Chen (2013) developed an additional set of measures capable to quantify the degree of circularity of production processes. The two studies led to the development of an index consisting of 3 main components: 1) an index related to resource input and consumption; 2) an other index related to resource flows and recycling, and finally 3) a last index related to output and resource management.

[23]This seems to be related to the launch of several pilot projects by Chinese institutions.
[24]The Data Envelopment Analysis (DEA) methodology is used to estimate the production efficiency of similar units by comparing them to optimal production frontiers.

Among the main contributions at the micro level we consider the study of Ellen MacArthur Foundation (2015), which developed an index known as the "Material Circularity Indicator" (MCI). According to the MCI, it is assigned a value between 0 and 1 to each factor in relation to the following aspects: input used in the production process, utility during use, post-use destination, recycling efficiency, risks and complementary impacts. This evaluation tool, athough shows a large degree of subjectivity, allows a first comparison between different realities[25]. Other indicators being the developed, including index provided by Park and Chertow (2014) and Di Maio and Rem (2015), measure the economic value related to recycling and recovery of components both for companies and products.

However, the main contributions in the literature, especially in recent years, can be traced to the macro-level. The studies are mainly focused on issues related to sustainability and environmental impact. As highlighted by the European Academies Science Advisory Council (EASAC, 2016)[26], some indicators very useful to analyze the level of environmental sustainability can be traced in the United Nations Environment and Development Programmes. Among the most relevant indicators there is the "*Environmental Performance Index"* (EPI)[27] created by Yale University together with the Word Economic Forum (Hsu A., 2016). The previously mentioned EASAC (2016) study also identifies those provided by the World Bank and the OECD (2016) as additional measures of environmental performance. Although these indicators are useful to explain the progress of different nations towards a long-term goal of environmental sustainability[28], the literature (EASAC, 2016) has focused on the analysis of material flows[29]. Through the study of the movements of natural resources of a country in relation to production, it is in fact possible to study the circular phenomenon in terms of input reduction.

A further macro-level index of CE has been provided by Ellen MacArthur Foundation (2015). This index is based on the following factors: resource productivity, circular activities, waste generation, energy and greenhouse gas emissions[30]. In addition to this, the European Union is proving to be very pro-active into building tools which can be used for analyses related to the Circular Economy (EASAC, 2016). Among the indices aimed to monitor the implementation of environmental policies identified by the "Europe 2020" Plan,

[25]At the company level, the index can be calculated as the sum of all the scores obtained for the different goods produced.

[26] European Academies Science Advisory Council (EASAC), "Indicators for a circular economy", 2016. Available at https://easac.eu/fileadmin/PDF_s/reports_statements/Circular_Economy/EASAC_Indicators_web_complete.pdf - updated to 15/06/2021.

[27] More information about "EPI Index" are available at https://epi.yale.edu/ - updated to 15/06/2021.

[28] We refer to the recent and widely discussed ESG issues (Environmental, Social and Governance) and their impact on Firms' Performance, Cost of capital and long-term Corporate value (Bellavite Pellegrini et al., 2020).

29 According to the European Union, material flow analysis shows the amount of physical inputs into an economy, the accumulation of materials within that economy, and outputs to other economies or in kind.
More details are available at https://ec.europa.eu/eurostat/documents/1798247/6191533/3-Economy-wide-material-flow-accounts...-A-methodological-guide-2001-edition.pdf/ - updated to 15/06/2021.

[30] Regarding the productivity, the approach identified aims to take into account the material resources used to produce one unit of gross domestic product, thus suggesting the use of the ratio between GDP and tons of DMI - Direct Material Input (a measure of all materials with economic value (excluding water) used for economic production). The second important factor concerns circular activities. Reference is made here to the level of recovery, recycling, sharing, and other factors relevant to CE. Some proxy measures proposed for use are so-called eco-innovation indices and recycling rates. The third aspect that is considered in the construction of the country index refers to waste generation within the economy. The indicators proposed to represent this factor are: waste generation per unit of GDP and the municipal solid waste production rate. The last relevant element relates to energy and greenhouse gas emissions. In order to represent environmental impact, the indicators that can initially be used refer to the share of renewable energy in the total and the emission of greenhouse gases per unit of GDP.

there is the "EU Resource Efficiency Scoreboard" (European Commission, 2011), a system of innovative indicators used to supervise the progress of countries towards an increase in the efficiency of material resources.

Finally, with regard to the intermediate level, also named "Meso" (Gisellini et at., 2016), which is positioned between micro (firms) and macro (nations) levels, the main contributions are related to cities, macro areas (industrial conglomerates) or economic sectors. Intermediate-level CE studies consider issues such as material resource productivity, ecological efficiency, and pollution within complex areas and/or sectors. The main methodologies used to assess the development of CE practices is the same of other two levels described previously.

A second strand of research identifies the potential benefits associated to implementation of circular economy models. In a study conducted by Ellen McArthur Foundation with McKinsey (2014)[31], these benefits are quantified in billions of dollars considering two possible future scenarios[32] for economic transition. At the macro and micro economic level, the main benefits consist of: i) material cost savings (ranging from 340 billion USD on an annual basis 630 billion USD); ii) mitigation of price volatility and supply risks (a drop in steel prices of up to 30%); iii) growth multiplier linked to sectoral transitions (employment growth for the recycling industry is assumed to be 500. 000 units for the European area alone); iv) various types of benefits for the economy (greater productivity of resources, greater innovative capacity, transition to a more skilled workforce); v) higher profit margins linked to the introduction of new business models; vi) potential growth for certain sectors (including, in particular, those of product re-sale, re-manufacturing and recycling).

In a recent study focused on three particular sectors, such as mobility, power systems, and the built environment (McKinsey, 2015), benefits are identified in terms of savings to move towards to a circular economy model, calculated in terms of production costs and primary resource use (over the next 15 years, savings of more than $1,800 billion have been quantified). Among other aspects, the adoption of more efficient technologies and circular business models, could also generate savings of $900 billion in terms of lower costs, as well as potential non-monetary benefits, such as improvements in social and environmental issues. A similar analysis conducted by the European Union (European Commission, 2014), identifies the following areas of opportunity: i) cost savings (worth 600 billion euros), due to the use of eco-design resources and a reduction and reuse of waste; ii) creation of new jobs (170,000) from the development of new business areas; iii) growth in gross domestic product (up to 3%), due to a lower and more efficient use of raw materials. However, the estimates presented are medium to long term estimates. Finally, another aspect of particular relevance concerns the disposal/recovery of waste. Among the policies suggested by the legislation[33] we found the principle of "extended producer responsibility", proposed for the first time in the literature, albeit with a lesser degree of

[31] Available at https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Ellen-MacArthur-Foundation-Towards-the-Circular-Economy-vol.1.pdf - updated to 15/06/2021.
32 First scenario assumes growth in line with current regulations and technologies (recovery rates increasing by 20-30%), while the second scenario assumes greater effort on the part of the various operators (recovery rates increasing by between 30% and 40%).
[33] Directive 1994/62, Directive 2008/98, and the European Union Action Plan (2015).

detail, by Lindhqvist (1990). According to the scheme defined in the study, producers, either by joining collective recovery schemes (normally managed by external organizations) or by acting on their own, have to bear the costs as well as fulfill the obligations related to the waste treatment/disposal process. This model, applied for the first time in Germany in the packaging sector, determined a significant reduction in total waste generated, and an improvement in recycling rates. Hanisch (2000), shows that between 1991 and 1998 in Germany, there was a quantitative reduction in packaging production of almost 16%. Starting from a comparative analysis of the main collective recovery schemes at the European level conducted by the European Commission (2014), some guidelines for an effective development of extended producer responsibility schemes were indicated. Among the most relevant aspects are: the coverage of costs for extended liability schemes and the operating methods of such schemes. With regard to the first aspect, the effectiveness of the application of such schemes is greatest if all (net) costs associated with separate collection and treatment of waste are effectively covered by producers. As regards the second aspect, the analysis shows two different scenarios. There are contexts in which several collective recovery organizations operate in competition (producers can freely choose which organization to join), and contexts in which one or two recovery organizations do not operate in competition. The analysis shows no preference for one model. However it seems fundamental for the effectiveness of such schemes, the monitoring of public authorities[34].

In this context, we want to mentionate the study by Cruz, Simoes and Marquez (2015), which compare five European countries (France, Germany, Portugal, Romania, UK), pointing out some evidence in favor of the competitive model. Specifically, it emerges that the competitive recovery model is generally characterized by greater cost efficiency. In contrast, Spasova and Lindhqvist (2014), considering Austria, Belgium, and Germany, suggest that these benefits are not directly correlated to increased competition among recovery organizations.

In general, an initial review of the relevant literature shows that the worldwide implementation of circular economy models has followed the dynamics of 3 R's (recycling, reuse and reduction). However, there is an ongoing debate on these issues due to the fact that many countries have followed significantly different paths and implemented different models, achieving different results from an CE perspective.

5. Sample analysis

In order to highlight the differences between different European countries, we decide to conduct an empirical analysis aimed to investigate the relationship between the different recovery/recycling models and the performance for those companies which adopted CE model between 2003 and 2016.

This choice, is closely related to the increased weight in policymaking by legislators. Over the years, Europe has shown increasing attention to Circular Economy issues followed by several directives aimed to define a common policy on the production and treatment of different types of waste. In the light of these aspects, a

[34] The Commission's study also provides legislators with guidance to increase transparency, standardize reporting methodologies and ensure consistent standards across European countries.

sample of 60 listed companies belonging to production of various types of packaging (plastic, glass, cardboard, metal), and raw materials (glass and paper), has been built through the use of two different databases, Thomson Reuters Refinitiv (Eikon/Datastream) and Orbis[35]. Table 3 shows industry classification of the sample.

Tab.3 - Classification by industry

Country	Industy		Total
	Packaging	Raw Materials	
Austria	1		1
Belgium	1		1
Bulgaria	2		2
Denmark	2		2
Finland	2	2	4
France	6		6
Germany	2		2
Greece	5		5
Ireland	1		1
Italy	1	1	2
Poland	4		4
Portugal	1		1
United Kingdom	6	1	7
Romania	1	1	2
Spain	1	5	6
Sweden	2	1	3
Switzerland	4		4
Turky	5	2	7
Total	**47**	**13**	**60**

Source: Thomson Reuters Refinitiv – Author's elaboration

If we consider the number of companies by individual country in 2016, we can notice that 51.7% of the sample is represented by France, the United Kingdom, Romania, Switzerland and Turkey. Regarding industry classification, the companies are distinguished in the table in two separate columns "Packaging" and "Materials". In the first column, all companies active in the production of packaging and containers of various materials are listed; while in the second column, companies producing specific materials (paper and glass)[36] have been included.

[35] Berau-Van DijK database.

[36] Based on the classification of the various companies in these sectors or areas of activity: a) Paper products, Containers and Packaging - According to the sectoral classification of Thomson Reuters Eikon (TRBC Sector); b) Containers and Packaging, Paper and Forest Products - According to the sectoral classification of Morgan Stanley Capital International (MSCI Sector); c) Manufacture of Glass, Manufacture of Paper - According to the so-called Nomenclature of Economic Activities in the European Community (NACE) used by Eurostat.

The total number of companies in the "Packaging" sector is 47, representing the largest percentage of companies in the sample. Of these, 25 operate in the packaging production sector and in paper production, in addition to 8 companies operating in glass production. Table 4 shows the average capitalization values of the companies in 2016.

Tab.4 - Average capitalization 2016 (€ mln)

Country	Market Capitalization (average)	Number of Companies	Market Capitalizazion/ Total Market Capitalization	Number of Companies/ Total number of Companies
Austria	1.684,40	1	3,9%	1,7%
Belgium	147,3	1	0,3%	1,7%
Bulgaria	154,4	2	0,4%	3,3%
Denmark	523,4	2	1,2%	3,3%
Finland	3.615,60	4	8,4%	6,7%
France	20.913,80	6	48,7%	10,0%
Germany	879,1	2	2,0%	3,3%
Greece	816,6	5	1,9%	8,3%
Ireland	26,8	1	0,1%	1,7%
Italy	2.793,10	2	6,5%	3,3%
Poland	250,8	4	0,6%	6,7%
Portugal	519,2	1	1,2%	1,7%
United Kingdom	49,9	7	0,1%	11,7%
Romania	42,6	2	0,1%	3,3%
Spain	516,3	6	1,2%	10,0%
Sweden	9.479,80	3	22,1%	5,0%
Switzerland	286,2	4	0,7%	6,7%
Turky	285,8	7	0,7%	11,7%
Total	**42.985,10**	**60**	**100,0%**	**100,0%**

Source: Thomson Reuters Refinitiv – Author's elaboration

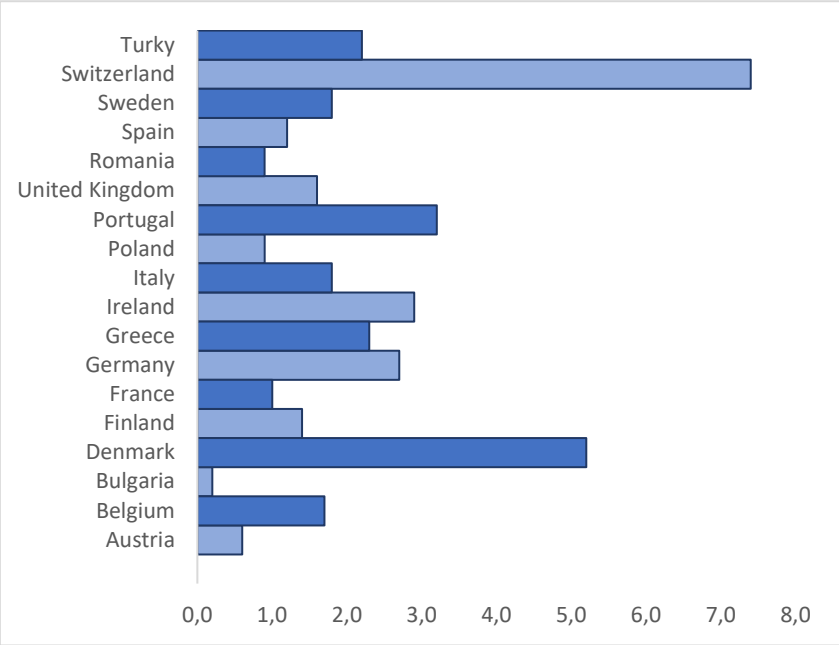
Analyzing market capitalization data, we can see that 85.6% of the total capitalization of the sample is represented by four countries: Finland, France, Ireland and Sweden (the average capitalization of the four Swedish companies represents 22% of the total, the six French companies 48%). Within the sample, it is possible to identify separately companies with high, medium and low capitalization. Northern countries are richer and more developed from an economic point of view, charachterized by a greater size; while, companies generally less economically developed are significantly smaller. In terms of revenues[37], on the other hand, it is possible to observe an average (median) figure for the period of 1,805 million euros (2.77 million euros), which in average terms recorded growth of 24% over the entire period under consideration, with a significant drop in the period between 2007 and 2009, linked to the repercussions of the American crisis on European

[37] We decided not to display descriptive statistics of revenue and other accounting variables to ensure greater readability.

markets. Among these companies, the 5 most stable in terms of turnover, operate in France, Sweden and Finland, while those with the highest levels of turnover are located in Romania and Greece.

With reference to the number of employees, we can observed that the majority of companies (around 40.3%) have between 1,000 and 10,000 employees, with an average value of 3,042. Among these companies, only 9 have a number of employees equal to or greater than 10,000, while small companies with less than 1,000 employees represent a more significant percentage (28 observations). Figure 2 shows the Debt/Equity ratio by country, calculated as an annual average of data from 2007 to 2016.

Fig.2 - Debt/Equity (Average frequency 2007-2016)



Source: Thomson Reuters Refinitiv – Author's elaboration

This ratio, considered as a proxy of companies' leverage, highlights that eight countries (44% of the total) show a value of leverage greater than 2 (average value 2.17). The observed level of debt thus seems to be associated with a financial structure that is primarily debt-oriented. If, on the other hand, the ratio of debt to market capitalization is observed, the average value is slightly higher and is equal to 2.5.

Table 5 shows the value of Return on Assets (ROA), calculated as the ratio between the value of Earnings Before Interest, Taxes, Depreciation and Amortization (EBITDA) and the company's total assets. The ROA (%), used in literature as a proxy for company profitability, shows an average value for the period of 1.74, thus indicating a good level of profitability.

However, when looking at individual countries, significant differences can be observed. The countries characterized by a higher average profitability are represented by: Austria (7.20), Spain (6.03) and Belgium (4.87); while those for which lower profitability is observed are: Switzerland (-4.52), Romania (-4.15), Denmark (-0.96) and United Kingdom (-0.18).

Tab. 5 - ROA (%) 2003-2016

Country	n°	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	Average
Austria	1	7,49	6,64	6,77	7,11	7,54	7,32	7,18	7,32	7,45		7,20
Belgium	1	2,00	3,22	7,69	7,48	4,50	3,88	4,91	5,36	4,75		4,87
Bulgaria	2				-7,28	2,41	1,96	1,61	2,68	0,33		0,29
Denmark	2	-18,45	-1,64	-0,64	2,67	2,28	-1,48	-4,34	4,09	4,34	3,61	-0,96
Finland	4	-1,39	-6,00	-3,43	4,20	0,01	2,18	2,33	3,39	6,25	5,21	1,28
France	6	1,89	-7,10	-2,15	6,94	0,87	-2,77	-2,66	6,16	2,99	3,60	0,78
Germany	2	4,48	5,42	4,78	4,33	3,45	1,78	2,41	1,43	2,14	5,12	3,53
Greece	5	0,98	-1,85	1,29	3,15	4,47	4,27	4,37	4,39	4,44	4,51	3,00
Ireland	1	1,56	0,70	1,37	-0,91	0,36	-1,54	1,61	2,97	1,88		0,89
Italy	2	1,68	-0,61	-1,51	0,63	2,45	2,84	2,28	2,84	4,70		1,70
Poland	4	5,74	6,07	4,26	5,64	4,97	2,94	3,93	3,81	4,67		4,67
Portugal	1	5,10	3,73	5,99	3,24	1,35	4,55	4,05	4,57	3,66	5,99	4,22
United Kingdom	7	-1,21	0,13	0,31	0,50	-0,89	-0,89	0,19	0,31	-0,06		-0,18
Romania	2	0,65	-5,47	0,19	-0,55	-20,34	-2,81	-10,86	-0,01	1,89		-4,15
Spain	6	6,21	4,48	4,66	6,86	7,85	6,50	5,43	5,70	3,74	8,90	6,03
Sweden	3	3,02	1,37	2,08	1,96	5,73	1,72	-0,77	-0,06	1,82	4,08	2,10
Switzerland	4	7,72	-0,33	3,22	-3,71	-14,51	-7,71	-15,48	-3,96	-12,38	1,95	-4,52
Turky	7	4,86	-5,42	1,47	2,73	4,56	2,99	-1,16	-0,43	-0,76	-3,13	0,57
Average	**60**	**1,90**	**0,20**	**2,14**	**2,50**	**0,95**	**1,43**	**0,28**	**2,81**	**2,33**	**3,98**	**1,74**

Source: Thomson Reuters Refinitiv – Author's elaboration

Finally, considering the ratio between turnover and number of employees, generally used as a proxy for the productivity of the company in terms of the efficiency of human capital resources, an (average) growth in company productivity can be observed. Not leaving out considerdation outliers, for which there is a minimum value of 1.36 in 2009, and a maximum of 902.05 in 2007, most companies show an average productivity between 100 and 200.

6. Results of empirical analysis

In order to investigate the existence of a positive relationship between the implementation of circular economy models of recovery/recycling and the profitability of companies operating in the sector of production and packaging of materials, the main econometric estimation models on *panel data* were implemented. In line with the previous literature on neo-classical models, such as the Capital Asset Pricing Model - CAPM (Sharpe, 1964) and the Arbitrage Pricing Theory (Ross, 1976) and the multifactorial models of Fama and French (1995), *firm-specific* and macro variables were considered in the regression model.

The specification of the model is reported below:

$$R_{it} = \alpha + \beta x_{it} + D_{it} + \varepsilon_{it}$$

where R_{it} is the "Total Return Index", α the constant, x_{it} is a vector of *firm-level* variables, D_{it} is a vector of dummy variables on CE issues, and ε_{it} is the standard error.

The analysis will be developed in several steps through different specifications of the regression model. The first econometric model proposed takes into account only the variables related to business fundamentals. Within this model, dummy variables on recovery and recycling rates will then be considered. Finally, the last specification of the model introduces dummy variables relating to the different waste stream management models.
For all model specifications, an estimation through the Ordinary Least Squares method (Pooled OLS) will be first tested. Then, the main *panel data* estimation methods will be implemented, namely the Fixed-Effects Model (FE) and the Random-Effects Model (RE).

The dependent variable of the model is the "Total Return Index" (return) which is measured by the annual percentage change in the total rate of return of the stock through the following formula:

$$\text{Total Annual Return} = (RI_t - RI_{(t-1)})$$

Where: RI_t= Return Index at time *t*;

$RI_{(t-1)}$= Return Index at time *t-1*;

It was then implemented a parsimonious set of control variables in order to avoid bias effects closely related to the trend of rates in different years of the time-series. The control variables considered are:

- Size, as a proxy for the size of the company, captured by the natural logarithm of the market capitalization measured by the product between the share price and the number of outstanding shares;

- Market premium, as the difference between a representative cross-country risk rate of return (the market return), and a common risk-free rate (Bellavite et al. 2008);

- Price volatility, measured by the percentage change in the stock price on an annual basis;

- Tobin's Q, as a proxy for the long-term growth value of a firm (Tobin, 1969), calculated from the ratio of the firm's market value to the replacement cost of capital stock.

Therefore, several dummy variables were implemented in the different models. In general, it is possible to split these variables into two categories:

1) the variables related to the recovery rate in packaging (Ellen MacArthur, 2015);

2) the variables related to the "extended producer responsibility" (ERP) principle.

With regard to the first category of dummy variables, built through the support of Eurostat[38] data on the recovery of waste from packaging, four different ranges were defined in order to highlight the different degree of commitment assumed by countries in the CE. According to the level of recovery, the size classes have been defined as follows:

1) High Level: equal to 1 for all countries within which, in the year, a recovery rate relative to packaging was achieved that is more than 16.5 points above the average score of the other countries, and 0 otherwise;

2) Medium High level: equal to 1 for all countries with a packaging waste recovery rate between the average of the countries for which observations are available and +16.5 points, and 0 otherwise;

3) Medium Low level: equal to 1 for countries with a recovery rate between -16.5 points and the average of European countries, and 0 otherwise;

4) Low level: equal to 1 for countries for which the recovery rate in the reference year was lower than 16.5 points compared with the average for European countries, and 0 otherwise.

The second category of dummy variables, on the other hand, verifies the application of the ERP principle. To this end the following variables were constructed:

- Extended Producer Responsibility: qualitative variable at macro level. This variable takes a value of 1 for all countries which implement an "Extended Producer Responsibility" scheme, and 0 otherwise;

- Competition between collective recovery organizations: qualitative control variable at macro-level. Extended producer responsibility schemes foresee the presence of collective recovery organizations (PROs), to which companies are required to adhere. Taking into account the PROs of the same type of material, a value of 1 is attributed to the variable, if there are more than 3 organizations operating in the market, and 0 otherwise.

Through the different specifications model we will therefore try to verify the following research hypotheses:

H1: "*The adoption of a "Circular" approach positively affects the performance of the company by determining an increase in Firms' Performance*".

H2: "*The implementation of "Extended Producer Responsibility" (ERP) schemes tends to reduce Firms' Performance*".

H3: "*The existence of multiple Collective Recovery Organizations (PROs) increases Firms' Performance*".

[38] "Eurostat is the statistical office of the European Union, based in Luxembourg (LU). It publishes official, harmonised statistics on the European Union and the euro area, offering a comparable, reliable and objective portrayal of Europe's society and economy." (definition available at https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Eurostat updated to 15/06/2021).

In order to verify the research hypotheses, a model with variables linked to business fundamentals will first be implemented; then, the dummies on CE issues seeking to observe whether the results of the first model are confirmed or present some variation.

Therefore, with the aim to guarantee a better reading of the results, only the outputs of the models for which it has been possible to observe statistically significant results will be presented.

The model firstly specified, considers the multi-factorial model of Fama and French (1995). In line with the literature, firm-specific variables were considered. The results of the Pooled OLS estimation confirm the previous literature, showing a positive and highly significant impact of all variables on Firms' Performance (Fama and French, 1995; Gompers P. et al., 2003; Harney and Tower, 2003; Bellavite et al., 2011). In particular, the most significant variable is the Risk Premium. Volatility also tends to have a positive and significant impact, as already highlighted by previous studies which point out that for securities with higher volatility coefficients, investors will demand higher premiums and as a consequence, the expected return will be higher (Duffee, 1995; Bellavite et al, 2011). Finally, Size, measured by the natural logarithm of market capitalization, also shows a positive and statistically significant relationship with the dependent variable, so that as firm size increases, returns tend to increase (Bellavite et al, 2008 and 2011). The last variable is Tobin's Q. Previous studies have shown different findings (Harney et al., 2003; Muhammad et al., 2014). Regarding the results of our model, a positive coefficient of Tobin's Q can be observed. Several studies that have analyzed the relationship between systemic risk and market effectiveness have shown that companies with a higher value of Tobin's Q, can be considered less risky (Chen et al.,1986).

Companies that are less risky in recession periods should in theory obtain better returns than those with greater exposure to risk. This consideration seems to be confirmed by our results and takes on greater relevance if we consider that the time-series also takes into account the years of the financial crisis of 2008 and sovereign debt of 2012.

The value of the R-square confirms a discrete explained variance of the model. The estimate using the Fixed-Effects (FE) method confirms Pooled OLS estimate, highlighting a positive and even more significant impact of the variables considered on Firms' Performance, with the exception of Tobin's Q. The estimate of the Random-Effects (RE) model is in line with that observed for the previous estimates. However, the results of the F-test, for the choice between the pooled OLS model and FE, and of the Hausman test, for the choice between the FE and RE methods, make it possible to reject the null hypothesis, identifying the fixed effects model (FE) as the best model to explain the reaction between the various variables considered and Firms' Performance.

Table 6 shows the results of the Pooled OLS estimation for the first model specification.

Tab.6: Pooled OLS and Fixed Effects (FE) estimation results [Model 1].

Variable	**OLS**	**FE**
Log Market Value	0.0371***	0,2750***
	(0,0115)	(0,0457)
Volatility	0,0104***	0.0282***
	(0,0024)	(0,0044)
Tobin's Q	0,0941***	0,0762
	(0,0357)	(0,0526)
Market Premium	0,8352***	0,7448***
	(0,0765)	(0,0813)
Constant	-	-2,1359***
	0,4962***	(0,2813)
	(0,1173)	
Observations	614	614
Number of groups	-	60
R-squared	0.2138	0.0934
Within R-squared	-	0.2790
Between R-squared	-	0.0356

Standard errors in brackets; p-value <0,01***; p-value<0,05**; p-value<0.1

The second specification of the model, as previously suggested, takes into account the variables relating to the recovery rates of the various countries. Through the implementation of the dummies related to the level of the firms' recovery rate, we attempt to highlight the presence of a positive relationship between corporate returns and a greater commitment by different European countries in achieving Circular Economy goals and related benefits (Ellen MacArthur, 2014; European Commission, 2014; Thomas 2001; Derwall et al., 2004; Anderson-Weir, 2010; Eccles et al., 2012).

Table 7 shows the output for the second model specification.

Tab.7: Pooled OLS estimation results [Model 2]

Variable	**OLS**
Log Market Value	0.0284***
	(0,0098)
Volatility	0,0131***
	(0,0048)
Tobin's Q	0,2441**
	(0,1044)
Market Premium	0,9884***

	(0,1443)
Alto Recupero	0,0556
	(0,0938)
Medio-Alto Recupero	0,0448
	(0,0969)
Medio-Basso Recupero	0,1581*
	(0,0922)
Constant	-0,7752***
	(0,2492)
Observations	496
R-squared	0.2347

Standard errors in brackets; p-value <0,01***; p-value<0,05**; p-value<0.1

The coefficients of the *firm-specific* variables show the same sign and are equally statistically significant. The main difference could be traced into the greater value assumed by the Tobin's Q, which goes from a value of 0.08 to 0.24. With regard to the three dummies on the recovery rate, a positive relationship with Firms' Performance can be observed, but it is not significant. The only dummy variable related to recovery rates that is statistically significant is the "Medium-Low Recovery" variable. The lack of significance of the "High Recovery" and "Medium-High Recovery" variables may be due, in the first case, to the constraints imposed by European regulations, which are very stringent for the packaging sector, influencing negative the performance of the companies themselves. In fact, the implementation of measures linked to the CE entails significant costs, which, at least initially, could have a negative impact on Firms' Performance, as shown by the analysis. Another possible reason why a significant impact cannot be observed may be due to a market that is not still mature and not yet able to recognize the benefits associated with a CE approach. On the other hand, the variable relating to levels of recovery that are slightly lower than average (Medium-Low Recovery) is statistically significant at 10%. The development at macro level of less binding regulations oriented towards CE (specifically waste recovery) seems to have a positive impact on company returns.

Also in this case, the Pooled OLS model was first implemented, and then the Fixed-Effects (FE) and Random-Effects (RE) models: Hausman tests, F-Test and the robustness tests (Huber-White) carried out suggest that the Pooled OLS estimate fits better. Finally, if we observe the value of the R-square, we can notice an higher value of the explained variance compared to the first model specification.

Table 8, on the other hand, shows outputs for the third and fourth models, which respectively also take into account the dummies relating to the application of "extended producer responsibility" (EPR) schemes and application methods such as "PROs Competition".

Tab.8: Pooled OLS estimation results [Model 3 and 4].

	(3)	(4)
Variable	**OLS**	**OLS**
Log Market Value	0.0368***	0,0355***
	(0,0087)	(0,0090)
Volatility	0,0094***	0.0108***
	(0,0032)	(0,0035)
Tobin's Q	0,0934**	0,1679**
	(0,0389)	(0,07433)
Market Premium	0,8090***	0,7879***
	(0,1035)	(0,1141)
Responsabilità Estesa del Produttore	0,0027	-
	(0,0363)	
PRO'ss Competition	-	0,1065**
		(0,0472)
Constant	-	-0,6091***
	0,4591***	(0,1510)
	(0,1183)	
Observations	726	645
R-squared	0.1960	0.2063

Standard errors in brackets; p-value <0,01***; p-value<0,05**; p-value<0.1

As described previously, the ERP principle extends the producers' responsibility to the entire life-cycle of the product, attributing in part or fully, the costs associated with waste disposal. Therefore, we expect a negative relationship between this variable and companies' returns (European Commission, 2001). Wherever, such schemes are implemented, the higher costs deriving from such schemes should, in theory, be correlated to a low performance. With regard to analysis, the consideration of dummy *time-invariant* variables, as highlighted in the existing literature, makes estimates with fixed-effects inadequate, for which, instead, estimation through the OLS method is better (Hausman and Taylor, 1981; Oaxaca and Geisler, 2003; Bellavite, 2008).

Starting from the analysis of the model in the first column, we can notece that the dummy variable relating to the implementation of the ERP principle is not statistically significant. This could be due firstly to the small size of the sample, and secondly to the macro-level characteristics of countries such as Denmark and Switzerland, the only two countries in which, even though EPR schemes are not regulated at a regulatory level (hence the dummy is equal to 0), they provide for systems linked to mandatory deposits, obtaining excellent results in achiving targets set by the European Union. The high recovery and recycling rates could lead to the hypothesis that the regulations introduced by both countries have had similar effects on companies as those achieved in other countries through the EPR schemes. Although it does not seem possible from this first analysis to identify a regulatory model that is more efficient in terms of its impact on businesses (extended

liability or other model), any specific effects may be found by analyzing in more detail the different ways in which the extended liability regime has been implemented.

With regard to the recovery organizations operating PROs, two specific scenarios have been defined, i.e. a competitive model, whereby several organizations compete with each other for the recovery of waste materials, or a monopoly regime, whereby only one, or at most two, organizations are authorized to recover waste materials. According to the evidence provided above, the choice of a competitive scheme does not seem to be particularly significant in terms of the performance of the various countries with respect to the recovery and recycling rates set by the European Union. The presence of a model with competing recovery organisations could, however, have a positive impact on the performance of the companies under observation.

Analyzing the second column, it is possible to observe a positive and statistically significant impact at 5% of the dummy variable "PRO's Competition" that confirms the third research hypothesis. This result can be explained as a lower costs for services and may be due to the presence and competition among the various organizations for recovery. Indeed, in line with the economic literature, we point out that as competition among recovery organizations increases, there is a lowering of the costs incurred by firms to join collective recovery schemes (Ferreira et al. 2014; CIWM, 2016). Therefore, this reduction seems to be consequently reflected in better Firms' Performance. In order to analyze the impact of the variable "Pro's Competition", we first exclude Denmark and Switzerland countries, in which the ERP schemes, over the years of the time-series, does not seem to be implemented. In this case as well, the presence of time-invariant variables makes the pooled OLS estimate the preferred one.

In general, we can observed that the control variables are similiar to the previous models, with the exception of Tobin's Q, for which a more significant impact can be observed, which goes from 1% to 5%. Therefore, it seems to emerge that companies can benefit significantly of lower costs relating to the presence of more than one recovery organization operating competitively. This result also seems to be of significant interest if we consider that these countries are characterized by different economic conditions. In conclusion, the results seem to provide significant evidence in support of the presence of economic benefits for companies operating in contexts with a competitive recovery model, confirming what has been observed in the literature on the CE.

7. Conclusion

The growing attention to issues of environmental, social and governance sustainability has led institutions, academics and practitioners to consider more carefully and from a long-term perspective the impact of companies on our planet. Natural resources, by definition scarce and finite (Meadows et al., 1972), will not be able to sustain the current economic system in the long term. The traditional economic system, based on a linear model of "take, produce and throw away" has proven to be unsustainable over the time. Therefore, the alarming environmental and economic data observed during the last decades have prompted a search for more sustainable economic models. In 1989, Pearce and Tuner first proposed the "circular" approach as an

alternative to the linear model, a system according to which the useful life of a product generally does not end with its consumption, but is based on a circularity of resources.

This research study analyzes the European context, which has shown a broad commitment to the CE, reflected in a significant production of regulations. At the same time, several scholars have attempted to verify whether the implementation of a "circular" approach could have a positive impact not only to the environment, but also for those companies operating in sectors that are heavily constrained by regulations.
Considering 18 European countries between 2003 and 2016, we aim to analyze the existence of a positive relationship between the different degree of implementation of a circular model and Firms' Performance. Specifically, we built a sample of 60 listed companies operating in specific industries such as packaging and paper and glass production, wich have adopted different business models of recovery and waste recycling.

Following a focus on the main regulatory developments up to 2015 and a literature review of the main contributions in the field of CE, three research hypotheses were defined. The first model specification, in line with the multi-factorial model of Fama and French (1995), takes into account a set of *firm-specific* variables, which has been implemented step by step with new "corporate" and institutional variables. Therefore, in order to assess the impact of these variables on the Firm's performance, expressed in terms of stocks returns (Bellavite Pellegrini et al. 2008), several specifications of the initial model were introduced.

First, the analysis sought to investigate the existence of potential benefits from the introduction of CE practices through the implementation of three dummy variables related to the level of recovery achieved for packaging waste, such as High Recovery, Medium-High Recovery, and Medium-Low Recovery. Findings show a positive but not significant impact, except for the last size-class. This result seems to be firstly justified in terms of cost, often excessive, especially in the initial phase of implementation of CE practices, which exceeds the level of benefits generated. A further reason could be traced into a not mature market, in a context too oriented towards CE objectives, which is still unable to recognize the benefits of the CE.

The second model specification takes into account the genearal adoption of EPR schemes. Also in this case, the coefficient while going in the hypothesized direction, is not statistically significant.
The lack of significance could be due, first of all, to the narrowness of the sample, and secondly to the macro-level characteristics of countries such as Denmark and Switzerland, the only two countries in which, even though EPR schemes are not regulated by law (hence the dummy is equal to 0), however they adopt systems linked to obligatory security deposits, obtaining excellent results in relation to the objectives set by the European Union.

The last model specification examines deeply the ERP scheme through the implementation of a new dummy variable relating to the presence of a competitive regime among collective take-back organizations (more than three). The results show a positive and highly significant impact on Firms' Performance, making it possible to confirm the last research hypothesis. In line with the main literature on CE, we can observed that as competition

among recovery organizations increases, Firms' Performance tends to increase. This could be due to lower costs incurred by firms to join collective recovery schemes (Ferreira et al. 2014; CIWM, 2016).

The empirical work thus provides evidence in favor to the implementation of CE practices. However only the third research hypotesis may be confirmed, highlighing that the CE issues are still under-explored, despite the existence of real benefits for companies. In fact, only by considering specific models of ERP, such as PRO's Competition model, is it possible to confirm the existence of benefits in terms of improved Performance. Studies on the benefits linked to the transition to a model of circular development focus on a medium-long time horizon. Another aspect that could have affected the significance of the results is the size of the sample. However, the narrowness of the sample is strongly related to the choice to analyze specific sectors, so it is not possible to observe a homogeneous distribution of observations in all countries. Nevertheless, the innovative aspect of this research work is to investigate the existence of these benefits with reference to specific sectors.

Future developments of the study will be closely associated to the approval of regulatory provisions. On June 14, 2018, four directives known as "circular economy package" were officialy approved, amending six of the previous directives on waste, packaging, landfills, electrical and electronic waste, end-of-life vehicles, and batteries. In particular, the package involves: Directive 2018/851 (amending Directive 2008/98/EC on waste), 2018/852 (amending Directive 1994/62/EC on packaging and packaging waste), 2018/850 (amending Directive 1999/31/EC on the landfill of waste), 2018/849 (of which art.1 amends Directive 2000/53/EC on end-of-life vehicles and articles 2 and 3 amend Directive 2006/66/EC on batteries and accumulators and waste batteries and accumulators and Directive 2012/19/EU on waste electrical and electronic equipment).

In the light of these considerations, and the growing importance of CE issues, the in-depth study of new regulatory aspects and additional corporate, institutional and ESG variables, could be interesting topics for future research agendas.

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Appendix a – definitions

According to Directive 2008/98/EC article 3 "Definitions", we report the main definitions provided by European Regulation.

"Article 3

Definitions

For the purposes of this Directive, the following definitions shall apply:

1. 'waste' means any substance or object which the holder discards or intends or is required to discard;

2. 'hazardous waste' means waste which displays one or more of the hazardous properties listed in Annex III;

3. 'waste oils' means any mineral or synthetic lubrication or industrial oils which have become unfit for the use for which they were originally intended, such as used combustion engine oils and gearbox oils, lubricating oils, oils for turbines and hydraulic oils;

4. 'bio-waste' means biodegradable garden and park waste, food and kitchen waste from households, restaurants, caterers and retail premises and comparable waste from food processing plants;

5. 'waste producer' means anyone whose activities produce waste (original waste producer) or anyone who carries out pre-processing, mixing or other operations resulting in a change in the nature or composition of this waste;

6. 'waste holder' means the waste producer or the natural or legal person who is in possession of the waste;

7. 'dealer' means any undertaking which acts in the role of principal to purchase and subsequently sell waste, including such dealers who do not take physical possession of the waste;

8. 'broker' means any undertaking arranging the recovery or disposal of waste on behalf of others, including such brokers who do not take physical possession of the waste;

9. 'waste management' means the collection, transport, recovery and disposal of waste, including the supervision of such operations and the after-care of disposal sites, and including actions taken as a dealer or broker;

10. ‘collection’ means the gathering of waste, including the preliminary sorting and preliminary storage of waste for the purposes of transport to a waste treatment facility;

11. ‘separate collection’ means the collection where a waste stream is kept separately by type and nature so as to facilitate a specific treatment;

12. ‘prevention’ means measures taken before a substance, material or product has become waste, that reduce:

    (a) the quantity of waste, including through the re-use of products or the extension of the life span of products;

    (b) the adverse impacts of the generated waste on the environment and human health; or

    (c) the content of harmful substances in materials and products;

13. ‘re-use’ means any operation by which products or components that are not waste are used again for the same purpose for which they were conceived;

14. ‘treatment’ means recovery or disposal operations, including preparation prior to recovery or disposal;

15. ‘recovery’ means any operation the principal result of which is waste serving a useful purpose by replacing other materials which would otherwise have been used to fulfil a particular function, or waste being prepared to fulfil that function, in the plant or in the wider economy. Annex II sets out a non-exhaustive list of recovery operations;

16. ‘preparing for re-use’ means checking, cleaning or repairing recovery operations, by which products or components of products that have become waste are prepared so that they can be re-used without any other pre-processing;

17. ‘recycling’ means any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes. It includes the reprocessing of organic material but does not include energy recovery and the reprocessing into materials that are to be used as fuels or for backfilling operations;

18. ‘regeneration of waste oils’ means any recycling operation whereby base oils can be produced by refining waste oils, in particular by removing the contaminants, the oxidation products and the additives contained in such oils;

19. ‘disposal’ means any operation which is not recovery even where the operation has as a secondary consequence the reclamation of substances or energy. Annex I sets out a non-exhaustive list of disposal operations;

20. ‘best available techniques’ means best available techniques as defined in Article 2(11) of Directive 96/61/EC.”

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