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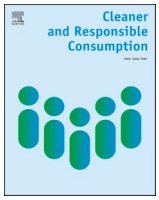

Bridging gaps in the demand and supply for circular economy: Empirical insights into the symbiotic roles of consumers and manufacturing companies

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ABSTRACT

Given the systemic nature of the circular economy (CE), its successful implementation necessitates a holistic approach involving all the relevant stakeholders across the production and consumption processes. This study focuses on the gap between the demand and supply of circularity by investigating transitioning profiles of consumers and manufacturing companies and examining their symbiotic roles in shaping a systemic circular transition. Using two extensive surveys involving 1000 consumers and 1443 manufacturing companies in Italy, and employing a cluster analysis methodology, we examined pro-environmental purchasing profiles among consumers and varying levels of circular practice integration among companies. The cluster analysis reveals four different consumer cluster based on their attitudes towards CE during the purchasing and post-purchasing phases. While the majority focused only on a single purchasing aspect, approximately one-third consistently optimized, preserved, and enhanced product value throughout the purchase phase and post-purchase use. Conversely, companies were grouped into five clusters according to their varying levels of circularity integration across the product life cycle. Only a small subset of companies fully embraced circularity throughout their entire product life cycle, with most concentrating their efforts on specific phases of the value chain. The findings highlight a significant gap between circular demand and supply: while the biggest cluster of companies comprises linear manufacturers, linear consumers represent the smallest segments. This underscores the need for comprehensive engagement from both manufacturers and consumers in shaping circular production and consumption. Based on a stakeholder perspective, the study opens up a discussion on how to bridge this gap, emphasizing the role of consumers with pro-circular behaviors in pushing companies to integrate circularity principles more thoroughly, and the role of companies in raising the awareness of linear consumers about the impact of their purchasing choices. By profiling circular companies and consumers and unveiling their behavioral tendencies, this research provides actionable insights for policymakers and managers navigating the circular transition.

1. Introduction

According to the World Population Prospects published by the United Nations in 2017, the global population is projected to reach approximately 9.8 billion people by 2050. This growth underscores an urgent need for resources, which is threefold what the planet can annually provide to sustain current levels of global consumption (United Nations, 2017). In response to this and other challenges of the 21st century—including resource depletion, climate change, and environmental damage caused by emissions and waste—the circular economy (CE) has emerged as a novel economic paradigm (Geissdoerfer et al., 2017; Stahel, 2016). The CE requires a holistic approach, encompassing production and consumption patterns throughout the entire value chain and calling for active engagement from all stakeholders involved in the

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transition process (Kevin van Langen et al., 2021; Linder and Williander, 2017).

In the context of the circular transition, production and consumption represent two interrelated and complementary components. Circular value management requires responsible resource utilization in the production of goods and services, as well as proactive and mindful consumption behaviors aimed at preserving the circular value (Kautish and Sharma, 2020; Kirchherr et al., 2017). Driven by the economic advantages they can gain, companies are progressively adjusting their production strategies by either modifying or adopting new circular business models (Gusmerotti et al., 2019; Moursellas et al., 2023). The integration of green practices such as sustainable procurement, waste reduction and energy efficiency push companies to develop needed capabilities to properly innovate and achieve sustainable targets (Difrancesco et al., 2022). Further, environmental factors such as regulatory pressure, stakeholders demand and emerging market are also influential in driving circular innovation in companies (Jabbour et al., 2020). Radical innovations for sustainability are serving as catalysts, enabling and inspiring the development of novel circular business models based on concepts such as modular design, remanufacturing, product-as-a-service, or sharing platforms (Ciccullo et al., 2023; Esposito et al., 2018). For example, through green design and sustainable product development companies can minimize environmental impacts throughout their whole lifecycle by directly affecting the procurement of green material, manufacturing processes and end-of-life disposal (Pigosso and McAloone, 2015). Conversely, through incremental innovation, traditional businesses are prompted to integrate CE principles into one or more phases of their product lifecycle. This involves leveraging concepts like circular supply chains, regenerative design, product life-extensions, and the cradle-to-cradle approach (Ceschin and Gaziulusoy, 2016; Corsini et al., 2015; Dumée, 2022; Tukker and Tischner, 2017).

The ultimate challenge of the CE can only be met by supporting the internal integration of circularity principles across all business functions (Aragón-Correa, 1998; Lanaras-Mamounis et al., 2022) and actively collaborating with external stakeholders to optimize the circular value of goods and services (Amasawa et al., 2023; Ferrón Vilchez et al., 2017). For instance, in technical cycles, the cooperation of consumers in redirecting materials towards further remanufacturing or recycling processes is essential (Moreno et al., 2016), highlighting the need for a holistic approach in achieving circular transitions. In this transition process, consumers play a pivotal role in reducing resource consumption during different product life stages and in keeping products' value within the socio-economic system, supporting closing loops actions (Kevin van Langen et al., 2021). Through their actions in the purchase, consumption, and end-of-life of a product, consumers can reduce the environmental impacts of the entire product lifecycle, contributing to the optimization of the product's circular value (Corsini et al., 2020; Testa et al., 2021).

From a systemic perspective, it can be summarized that companies and consumers play a symbiotic role in the transition towards the CE. While companies must guide consumers towards circular purchasing choices and respond to their demand for circularity (Hosta and Zabkar, 2021), consumers, through their pro-environmental behaviors, are pivotal in boosting companies' circular innovations through the implementation of circular practices across various stages of the lifecycle. The literature provides numerous contributions on the adoption of circular practices by companies (Barreiro-Gen and Lozano, 2020; Gusmerotti et al., 2019; Lanaras-Mamounis et al., 2022; Lieder and Rashid, 2016; Stewart and Niero, 2018) and consumers responsible behavior (Chu et al., 2023; Du Rietz and Kremel, 2023; Kevin van Langen et al., 2021; J. Wang et al., 2021a). However, the integration of both perspective in investigating the imbalance between the demand and supply of CE is still scant. This study seeks to fill this gap by exploring the symbiotic role of demand and supply in supporting the transition to a CE. Specifically, it aims to profile consumers and manufacturing companies based on their circular behaviors and practice, and to explore how the interaction between these profiles contribute to supporting a systemic transition towards CE, discussing how synergies and divergences could enhance this transition. Accordingly, it answers the following research questions: *What are the profiles of manufacturing companies and consumers transitioning towards a circular economy? How can bi-directional interactions between the profiles of these companies and consumers foster a systemic transition towards a circular economy?*

From a stakeholder theory perspective, different companies and consumers profiles could play interconnected roles in driving the transition towards a CE. Stakeholder theory suggests that companies must consider the interests and influence of various stakeholders, including consumers, who exert pressure on organizations to adopt sustainable practices (Freeman et al., 2010). In the context of CE, consumers can act as key stakeholders, pushing companies to integrate circular principles into their operations, while companies also guide consumer behavior by offering circular products and transparent information. This study applies stakeholder theory to examine the mutual influence between companies and consumers profiles in fostering a systemic transition towards a circular economy.

This study contributes to research and practice by providing a unique perspective on the mutual influences between companies and consumers that can boost CE throughout the production and consumption cycles. First, it adds to the growing academic debate by profiling companies based on their readiness for the circular transition and evaluating consumer characteristics distinguished by different purchasing behaviors. It extends previous literature by integrating a bidirectional stakeholder perspective between consumers and companies, which had been examined separately in prior studies. Second, this study identifies the gap between circular demand and supply and suggests ways to overcome it by investigating the mutual pressures that companies and consumers exert through their actions to stimulate circular production and consumption. Rooted on a stakeholder perspective, this study presents a framework highlighting the symbiotic relationships between companies and consumers at the core of a dynamic loop that fosters a systemic transition towards a CE. Lastly, by profiling circular consumers and identifying their psychological and behavioral tendencies, this study offers several implications for managers seeking to implement the circular transition. These insights can help companies leverage consumer demand to access new markets and drive the adoption of circular practices.

The structure of this article is as follows. The second section presents the background, exploring the symbiotic role of companies and consumers in advancing the circular transition and reviewing previous profiling based on their engagement with circular practices. The third section outlines the research design and the description of companies and consumers samples, offering insights into the data collection process and the statistical measures employed. Section four presents the data analysis results and findings. Section five discusses the findings and their implication for research and practice. Finally, the last section addresses the study's conclusions.

2. Background

Companies and consumers, based on their level, play interdependent role in shaping the supply and demand of circular products, and their interaction can advance the systemic transition towards CE. This background section explores the mutual influences between these key actors of the transition based on a stakeholder perspective. Further, it reviews how consumers and companies have been profiled in terms of their engagement with CE, focusing on the key phases of production and consumption.

2.1. Shaping circular demand and supply: a stakeholder perspective

Since the circular transition is gradual process that requires a

systemic approach from all actors involved in, understanding the roles and interactions between key stakeholders is acquiring increasingly important (Jabbour et al., 2020). Both consumers and companies play pivotal roles in shaping the demand and supply of circular products and services, and they exert mutual pressures that can act as catalysts for the transition. To analyze these interactions, the stakeholder perspective offers valuable insights into how different stakeholders influence and drive the transition.

Stakeholder Theory (SHT), originally conceptualized by Freeman (1984), proposes that organizations must consider the interests of all stakeholders, that are individuals or groups who can affect or be affected by the organization's actions. According to this framework, organizations should actively engage with a broad set of stakeholders, including employees, customers, suppliers, and communities, to balance their diverse needs and interests (Freeman et al., 2010). In the context of CE, stakeholders theory provides valuable lenses for analyzing and interpreting relationships between companies and consumers. Consumers act as key stakeholders, influencing companies to adopt circular practices through their purchasing behaviors and demand for sustainability. At the same time, companies can influence consumers by supplying sustainable products and services and shaping their behavior towards more circular consumption patterns. Through their purchasing choices, consumers can exert pressure on manufacturing companies to integrate CE principles starting from the early stages of the product lifecycle, such as design and production (Carrete et al., 2012). On the other hand, the consumers face several barriers in translating a positive attitude into concrete circular actions (Di Iorio et al., 2023). For example, a lack of information on the environmental characteristics of products or the presence of vague or misleading information may discourage consumers from pro-environmental behavior or lead them to ineffective actions (Testa et al., 2021). Companies play a crucial role in overcoming these barriers by providing accurate and transparent information about circular products, thus stimulating consumers' awareness on product's performance and the likelihood of adopting consumption behaviors coherent with their values (Hosta and Zabkar, 2021; Nguyen et al., 2021). These mutual relations highlight the influence that companies and consumers, as different stakeholders, exert in shaping production and consumption towards CE, making SHT particularly relevant for this context.

In recent years, SHT has proven to be a valuable framework for analyzing the transition toward the CE by highlighting the critical role of diverse stakeholders in shaping organizational decision. For example, Jabbour et al. (2020) examined the influence of internal and external stakeholder pressures on companies' ability to overcome barriers to CE adoption. They illustrate that stakeholder engagement, including shareholders and employees, significantly shapes the firm's ability to implement sustainable practices and improve performance (Jabbour et al., 2020). Similarly, Schultz et al. (2023) emphasize the need for stakeholder collaboration in achieving CE transitions. By advocating for governance models that promote collaboration beyond company boundaries, they highlight the importance of stakeholder-driven collective governance in advancing the CE agenda.

The role of stakeholder engagement is further explored by Salvioni and Almici (2020), who demonstrate how fostering relationships with stakeholders helps organizations align their operations with social and environmental sustainability goals. Gupta et al. (2019) extends this idea by discussing the role of data and information sharing among stakeholders, which facilitates informed decision-making in supply chains and supports CE goals.

Consumers, as key stakeholders, also play a crucial role in influencing corporate strategies. Aboulamer (2018) highlights that shifting consumer preferences toward sustainable products encourages companies to adopt circular business models. However, Stewart and Niero (2018) show that while companies increasingly integrate CE principles into their strategies, consumer engagement remains limited, despite its importance in driving successful circular transitions.

While previous research has highlighted the broad influence of stakeholders in driving the circular economy, the stakeholders lens become even more relevant when examining the diverse profiles of both consumers and companies based on their level of engagement with circularity. In this study, we recognize that not all consumers or companies contribute to the CE in the same way; rather, they can be segmented into distinct profiles according to their behaviors and strategies. Circular consumers, who are deeply committed to sustainable practices, exert different pressures on companies compared to linear consumers, who may prioritize convenience over environmental impact. Similarly, circular companies, which fully integrate circular principles across their entire product lifecycle, operate very differently from linear companies, which may only adopt selective practices or none at all.

This distinction paves the way for further investigation into how these consumer and company profiles have been measured in the literature, particularly regarding their role in shaping the demand and the supply of circularity. Thus, the next section reviews how previous studies have profiled consumers and companies based on their level of engagement with circular economy practices.

2.2. *Profiling consumer behaviors and corporate practices across the lifecycle*

In the literature, several studies have independently profiled consumers and companies using different models and variables to capture their engagement with CE by considering the unique actions that both can take. When analyzing circularity demand from consumers, previous research has focused on behavioral patterns during the purchase, usage, and end-of-life stages of a product, providing insights useful in understanding how companies should adapt to meet the demand (Corsini et al., 2020). Arias et al. (2022) profiled pro-circular consumers based on their behaviors, considering factors like moral norms and perceived consumer effectiveness. They identified four main consumer profiles, ranging from those distant from pro-circular behavior to fully circular consumers, focusing on intermediate profiles like occasional circular behavior or consumers on the path to full circular behavior. Fogarassy et al. (2020) focused on circular consumers' attitudes toward food purchasing, unveiling information-dependent customers, who make decisions based on the availability of product information, and direct purchasers, who value direct contact with sellers, often preferring short supply chains.

Considering the key types of practices about CE, consumers shape the circular demand and influence the circular supply in several ways, both in buying and post-purchasing phase (Lüdeke-Freund et al., 2019; UNI, 2022). The *purchasing phase* refers to actions such as selecting products and making the purchasing choice, while the *post-purchasing phase* refers to the period after a product has been bought and is being used by the consumer. For a comprehensive assessment, these phases need to be rooted into dimensions that describe the circular potential of consumer actions. The circular principles of preservation, optimization, and regeneration of value from the Ellen MacArthur Foundation (EMAF, 2012) offer a useful framework to describe circularity in both purchasing and post-purchasing phases. Value preservation refers to maintaining the functionality and value of a product as long as possible; value optimization pertains to the minimization of material use and efficient resource management; and value regeneration involves the ability to restore or regenerate value at the end of a product's life, focusing on material reuse and proper end-of-life management.

Conversely, evaluating manufacturing companies based on their level of circular practices implementation throughout the product lifecycle can unveil various profiles of readiness towards the circular transition (Pigosso and McAloone, 2021). Gusmerotti et al. (2019) analyzed companies' CE approaches, paying attention to different steps of the product value chain. They revealed five different companies' profiles implementing circularity principles in one or more lifecycle stages. In addition to fully linear or circular companies, they identified

companies that solely focus on the product design, logistic and end-of-life information. Recently, Zomer et al. (2024), based on eight dimension and aspects of organizational readiness, clustered companies according to five readiness profiles: laggards, explorers, frontrunners, strategizes and information oriented.

Consistent with previous studies (Gusmerotti et al., 2019), the measurement of CE implementation in manufacturing companies can be conducted according to the product lifecycle stages framework from the Ellen McArthur Foundation (EMAF, 2015). This framework outlines actions that companies can take at each stage of a product's lifecycle, covering phases such as product design, material procurement, manufacturing, distribution, consumption, maintenance, reuse, refurbishment, and recycling. Some phases provide greater opportunities for company intervention, such as during the design, procurement, and manufacturing stages, where companies can directly influence product circularity by maximizing value retention. However, in later stages like consumption and end-of-life, the involvement of external stakeholders, particularly consumers, becomes crucial. By aligning the entire product lifecycle with the company's ability to integrate circular actions, four key phases can be used to describe the product lifecycle.

The *procurement* of materials is a critical phase for companies to preserve the resource value within a closed-loop system. Reusable, recyclable, or compostable materials should be prioritized to maximize their integration throughout the value chain. Additionally, the procurement of mono-material packaging facilitates consumers in differentiate waste collection as well as recycling process. In the *product design* phase companies can focus on creation of circular and regenerative systems where products have extended lifecycles and resources circulate within closed loops, affecting the circularity in the whole product's life cycle (Bocken et al., 2016; Cayzer et al., 2017). *Process efficiency* is a core aspect for maintaining circularity in operations by preserving resource flows and minimizing waste. Waste from the production process and End-of-Life products should be recycled and reintroduced into the company's production process (De Pascale et al., 2021) or shared with other industries through industrial symbiosis practices (Chertow and Ehrenfeld, 2012). Furthermore, when recycling is no longer viable, energy recovery offers a preferable solution to disposal. Finally, *logistics* also play a crucial role in implementing CE principles by enabling closed-loop systems and minimizing climate change impacts through optimized resource movement and distribution.

Using comprehensive frameworks to profile companies and consumers based on their level of CE integration in the production and consumption stages can provide a clear picture of progress toward a circular transition and help identify gaps between demand and supply (EMAF, 2012). Furthermore, since different consumer and company profiles may have varying needs, expectations, and exert different pressures - creating feedback loops - this study also investigates how these groups can influence each other toward a systemic transition.

3. Methods

This section first explores the research design and context of the study. It then outlines the data collection process, sample characteristics, and measurements used in the two surveys conducted on manufacturing companies and consumers. Finally, it describes the approach employed for data analysis.

3.1. Research design and context

To comprehensively analyze the gap between the demand and supply of CE, this research was designed to profile both manufacturing companies and consumers based on their readiness and approaches to circular production and consumption. Using a quantitative assessment and cluster analysis, this study aimed to uncover the synergies and gaps between demand and supply, ultimately drawing a framework that highlights the interplay between companies and consumers to foster a systemic transition. Two studies were conducted employing different questionnaire-based surveys: Study 1 explores the level of adoption of circular practices within a large sample of manufacturing companies, whereas Study 2 investigates the consumers' circular purchasing and behavior trends.

The surveys targeted large sample sizes, encompassing 1000 consumers and 1443 manufacturing companies in Italy. The focus on the Italian manufacturing context relies on several motivation. First, Italy represents the second-largest manufacturing sector in Europe, as reported by Eurostat (2023). Second, Italy's industrial landscape closely aligns with key features of the broader European economy, including the composition of companies in terms of size and industrial sector. Additionally, from a consumer perspective, the Italian prominence in highly impactful industries, such as in food and textiles, makes it particularly suitable for this study. In these sectors, consumer behavior is pivotal in successfully closing the loops of circular systems (Busalim et al., 2022; Du Rietz and Kremel, 2023; Laureti and Benedetti, 2018). The following paragraphs provide detailed information on the data collection and measurements adopted in both studies.

3.2. Study 1—manufacturing companies

3.2.1. Data collection and sample description

To assess the level of integration of circular economy practices in Italian manufacturing companies, the population of firms associated with the Italian National Packaging Consortium (CONAI) was selected as the target of the survey. The CONAI consortium includes a comprehensive range of Italian companies involved in the production, distribution, use, and recycling of packaging, making its associates a highly representative subset of the entire Italian manufacturing sector. Thus, CONAI consortium was chosen due to its extensive representation of various sectors within the Italian manufacturing industry, ensuring that the sample included companies with diverse experiences and practices related to CE principles. By leveraging CONAI's involvement, the survey successfully reached a population of over 43,500 manufacturing companies via email. The size of the sample endures that the sample accurately reflects the population, reducing the risk for sample bias.

The questionnaire was carefully designed to capture comprehensive data on CE practices. Prior to administration, a pilot test was conducted involving a select group of managers from the target sample. These managers were invited to review the questionnaire and provide feedback on content clarity and potential misunderstandings. Based on their input, several questions were revised for clarity and simplicity. This iterative process helped ensure the questionnaire's effectiveness and relevance.

The questionnaire was administered through a web-survey platform from May to June 2022. To maximize the response rate, reminders were sent 15 days after the initial invitation and again and one week before the expiry period. To reduce social desirability bias, anonymity was ensured for the participating companies, as recommended by (Nederhof, 1985). A total of 2447 companies completed the questionnaire, resulting in a response rate of 5.62%. However, after removing answers with missing data, only 1443 responses were considered suitable for inclusion in the present study. This corresponded to an effective response rate of 3.31%. Applying the Dillman (2011) formula to calculate the sample representativeness, the margin of error associated with the study is 2.53% with an accuracy level of 95% (Dillman, 2011), indicating a high level of sample representativeness. To check for non-response bias, we compared the characteristics (e.g., size, turnover variation, circularity performance) of early and late respondents, based on the assumption that late respondents have similar characteristics to non-respondents. No significant differences were found, suggesting that non-response bias does not affect this study.

Table 1 provides a detailed breakdown of the sample, showcasing representation across various sectors of activity. Notably, the packaging manufacturing sector constituted 23.7% of respondents, followed by the

Table 1
Sector of activity of the firms responding to the survey.

Sector of Activity	Freq.	Percentage
Manufacturing of packaging	342	23.7%
Metals sector	294	20.37%
Manufacturing of textiles	168	11.64%
Manufacturing of food products	140	9.7%
Electric and electronic sector	136	9.42%
Manufacturing of furniture and decor	112	7.76%
Manufacturing of chemicals, cleansing and cosmetics	76	5.27%
Manufacturing of motor vehicles	65	4.5%
Distribution sector	59	4.09%
Manufacturing of beverages	27	1.87%
Pharmaceutical sector	23	1.59%
Total	1443	100.00%

metal sector, which accounted for 20% of the sample. Conversely, sectors such as beverage production and pharmaceutical each represented less than 3% of the sample, aligning with data from the Italian Statistical Institute (Istat, 2023).

In terms of the number of employees, approximately 60% of the companies in the sample are classified as small-sized, with fewer than 25 employees. Large companies, with more than 250 employees, make up 5% of the sample (Table 2). The remaining companies fall into the medium-sized category, with employee counts ranging from 26 to 250. Regarding the market target of these companies, 16% operate in the local market (e.g., regional or interregional), 39% operate at the national level, 30% export their products within the European market, and the remaining 15% export outside of Europe as well. Lastly, considering the variation in turnover over the past three years, 20% of the companies experienced a decrease, 54% reported an increase, and 26% observed no substantial changes.

3.2.2. Measurement

The survey design process and the subsequent scale development were structured according to the outline of Hensley (1999). A set of fourteen items listed in Table 3 was used to examine the circularity level of the manufacturing activities. To ensure a sufficient sensitivity level in the collected responses, an 11-point Likert scale ranging from 0% to 100% was adopted for all the questions (Leung, 2011). These items were grounded in academic literature and indicators from existing tools for assessing circular economy performance (CEP), such as those provided by the EMAF (2015). The items were translated into Italian and contextualized to evaluate the CEP across the key phases of the product life cycle where the manufacturing context can have a direct impact. Thus, various activities that companies can implement in the phases of material procurement, product design, production process efficiency, and distribution logistics were considered (Lewandowski, 2016).

Drawing on the works of Wen and Meng (2015) and Saidani et al. (2019), ITEMs from 1 to 5 were selected to assess the performance of a circular procurement of materials for product production and for its packaging. ITEM6, ITEM7, and ITEM8 were selected to measure the extent to which companies integrate eco-design practices to enhance the durability, and recyclability of the products, as well as the optimization of the usage of the material. (Bocken et al., 2016; Cayzer et al., 2017).

Table 2
Size of the firms responding to the survey.

	Freq.	Percentage
Less than 25 employees	823	57.03
Between 26 and 50 employees	261	18.09
Between 51 and 100 employees	154	10.67
Between 101 and 250 employees	133	9.22
Between 251 and 500 employees	45	3.12
More than 501 employees	27	1.87
Total	1443	100%

Table 3
Measurement scales for circular economy performance.

Constr.	ID	Items	Alpha	Sources
Supply	ITEM1	Percentage of renewable raw materials or semi-finished products out of the raw materials or semi-finished products used by the company.	0.73	Wen and Meng (2015)
	ITEM2	Percentage of recyclable raw materials or semi-finished products out of the raw materials or semi-finished products used by the company.		
	ITEM3	Percentage of packaging composed entirely of recycled material out of the total packaging used for the company's products.		
	ITEM4	Percentage of packaging composed entirely of mono-material out of the total packaging used for company's products.		
	ITEM5	Percentage of recycled material contained in the packaging used for the company's products.		
Design	ITEM6	Percentage of products designed to have the highest possible durability (products that are easily disassembled or repairable, non-perishable products) out of the products sold by the company.	0.68	(Bocken et al., 2016; Cayzer et al., 2017)
	ITEM7	Percentage of primary/secondary packaging designed and produced to be recyclable, out of the total packaging used for the products sold by the company.		
	ITEM8	Percentage of products and packaging designed to optimize loads during the transportation and distribution phase out of the total products sold by the company.		
Logistics	ITEM9	Percentage of trips (for receiving raw materials, semi-finished products, or packaging, or for delivering the products) where reverse logistics measures have been implemented.	0.68	(de Souza et al., 2022; Julianelli et al., 2020)
	ITEM10	Percentage of trips (for receiving raw materials, semi-finished products, or packaging, or for delivering the products) where routes and loads have been optimized.		
	ITEM11	Percentage of trips (for receiving raw materials, semi-finished products, or packaging, or for delivering the products) where less impactful vehicles (e.g., vehicles powered by biofuels, electric vehicles, Euro 6		

(continued on next page)

Table 3 (*continued*)

Constr.	ID	Items	Alpha	Sources
		vehicles) or intermodal solutions have been utilized.		
Production Efficiency	ITEM12	Percentage of production waste reintegrated into the company's production process or transferred to other companies out of the total production waste.	0.61	(Chertow and Ehrenfeld, 2012; De Pascale et al., 2021)
	ITEM13	Percentage reduction in the amount of waste generated per unit of product.		
	ITEM14	Percentage of waste weight sent for material and energy recovery out of the total waste produced.		

Grounding on the research of de Souza et al. (2022) and Julianelli et al. (2020), ITEM9, ITEM10, and ITEM11 were selected to assess the extent to which companies integrate load and route optimization, as well as reverse or intermodal logistics. To capture aspects of the circularity process efficiency, such as the optimization of resource use, the EoL and waste management, ITEM12, ITEM13, and ITEM14 were selected from De Pascale et al. (2021) and Chertow and Ehrenfeld (2012). The full version of the questionnaire administered to manufacturing companies is available in Appendix A of the Online Supplementary Information.

Demographic variables of the companies were also assessed. Specifically, the number of employees was utilized as a proxy for company size. Moreover, variations in turnover and the number of clients over the previous three years, as well as the primary market for product sales and the number of competitors in this market, were examined to explore patterns related to the company's implementation of circularity.

3.3. Study 2—consumers

3.3.1. Data collection and sample description

For the study on consumers, we collected data through a questionnaire-based survey as well. The questionnaire was administered online in July 2022 by a professional survey-service provider, reaching a large sample of 1000 Italian consumers aged 25–70. The provider ensured that the sample aligned with the key demographic characteristics of the Italian population, such as age and geographical distribution, with a confidence interval of ±3.1%. However, it should be noted that the sample has a higher representation of females (64.7%) compared to males (35.3%). This imbalance does not generate concerns, as women often play a key role in household purchasing decisions, particularly in the context of sustainability behaviors (Kennedy and Kmec, 2018). To further ensure that this gender imbalance did not affect the study's validity, we performed t-tests to examine any potential variations in responses, revealing no significant differences in the key variables. Additionally, we compared the other sample's demographic characteristics to ensure effective representativeness and address potential concerns about sampling bias. Further, as previously described, we compared demographic characteristics and consumer behavior variables between early and late respondents, finding no significant differences, which suggests the absence of non-response bias. The sample demographic characteristics are shown in Table 4.

Table 4
Sample demographics.

Demographics	Values	Sample n = 1000	
		Absolute frequencies	%
Gender	Male	353	35.30%
	Female	647	64.70%
Age class	25–34	95	9.50%
	35–44	183	18.30%
	45–54	257	25.70%
	55–64	240	24.00%
	65 +	225	22.50%
Geographical origin	North-west	328	32.80%
	North-east	188	18.80%
	Center	174	17.40%
	South + islands	310	31.00%
City size	Less than 10.000 inhabitants	259	25.90%
	Between 10.000 and 30.000 inhabitants	233	23.30%
	Between 30.000 and 100.000 inhabitants	216	21.60%
	More than 100.000 inhabitants	292	29.20%
Education	Graduate and high school	678	67.80%
	Middle school, elementary school, or no title	322	32.20%
Job condition	Employed	571	57.10%
	Unemployed	429	42.90%
Family income	less than 600 euros	33	3.30%
	about 600 euros	19	1.90%
	about 800 euros	32	3.20%
	about 1.000 euros	54	5.40%
	about 1.200 euros	90	9.00%
	about 1.400 euros	81	8.10%
	about 1.600 euros	75	7.50%
	about 1.800 euros	62	6.20%
	about 2.000 euros	103	10.30%
	about 2.500 euros	85	8.50%
	about 3.000 euros	98	9.80%
	about 4.000 euros	44	4.40%
	More than 4.000 euros	44	4.40%
	No answer	180	18.00%

3.3.2. Measurement

To measure behaviors that consumers can implement to favor a more CE model, we used different items and scales. Within the construct of "value preservation", we used items focused on the behaviors of buying second-hand products (such as clothes or furniture) or opting for shared solutions (e.g., clothes rental services) as well as, during the use phase, the behaviors of contributing to the durability of products, fully exploiting their useful life and reusing them intelligently instead to replace. To measure "value optimization" we used items related to the behaviors of purchasing products with minimal use of materials (which therefore do not use excessive materials, components, and packaging) and to the commitment - in the post-purchasing phase - to be efficient in the use and avoid product waste. Then, within the dimension of "value regeneration" we measured behaviors related to the act of choosing – during the purchase phase - products or packaging made with recycled material or—in the post consumption phase - of making a proper separate collection of materials in order to support recycling. To design our measures, we took inspiration from scales and items used in previous studies, modifying and re-adapting them to better fit our purpose. Table 5 shows our multi-item scales used to measure preservation, optimization and regeneration behaviors. The full version of the questionnaire administered to consumers is available in Appendix B of the Online Supplementary Information.

We also measured other psychological and behavioral dimensions that can characterize consumers and someway influence their purchasing and post-purchasing actions. To measure our constructs of interest we first took inspiration from validated scales used by previous academic studies, revising, enriching and adapting them when necessary. For example, to measure the construct of "environmental concern" we took inspiration from generic items used by (Jin Gam, 2011; Trivedi et al., 2018), elaborating also new items focused on more specific environmental topics (e.g. climate change, water scarcity, impact of food sector).

In some cases, we developed our innovative measurement scales,

Table 5
Measurement scales for preservation, optimization and regeneration behaviours.

	Constructs	Items	Response	Alpha	Sources
Purchasing	**Preservation** (Focus on second-hand and sharing)	If I have to participate in a ceremony, I prefer to rent/borrow the dress, to avoid waste When I need to buy furniture, I try to find a used one that fits my needs When buying clothing, I chose second-hand items (clothes, accessories, etc.).	From 1 = "never" to 5 = "Always/Every time it is possible"	0.7	Merdin-Uygur (2019)
	Optimization (focus on choosing products made with minimal use of resources)	When buying bakery products (e.g. bread, rolls, etc.) I chose those with minimal design packages (e.g. mono-material or few materials) Whenever possible, I bought bulk cleaning products When buying chocolates, I bought products with minimal packaging made from one or a few materials	From 1 = "never" to 5 = "Always/Every time it is possible"	0.63	Our elaboration
	Regeneration (Focus on Recycled Materials)	When purchasing paper products, I have always chosen recycled ones when available When buying biscuits or similar products, I have bought those with recycled packaging when available When buying bottled drinks, I choose those with recycled packaging when available When choosing between personal care products (e.g. shampoo, shower gel, etc.), I bought the one with packaging made from recycled material	From 1 = "never" to 5 = "Always/Every time it is possible"	0.75	Testa et al. (2020)
Post-purchasing	**Preservation** (Focus on durability and reuse)	If I realize that an electronic product is not designed to last over time, I avoid buying it For me it is very important that a product is designed to last over time, I am not inclined to replace it if not necessary I am very inclined to creatively recycle objects that have fallen into disuse, devising new ways of using them, developing original and economical solutions, for example for furniture, clothing or other When I ran out of liquid hand soap, I reused the bottle by refilling it When I finished a packaged food product, I tried to reuse the container for other purposes, whenever possible	From 1 = "never" to 5 = "Always/Every time it is possible"	0.61	Merdin-Uygur (2019)
	Optimization (focus on efficiency during use)	When using a shampoo or shower gel, I used the amount strictly necessary to avoid product waste When I did my laundry, I followed the recommended dosage on the package When preparing my meals, I carefully weighed the amount needed to avoid waste If a food item had a close expiration date, I ate it before the other items	From 1 = "never" to 5 = "Always/Every time it is possible"	0.7	Our elaboration
	Regeneration (Focus on recycling)	When I consumed a food product packaged with multiple materials, I carefully separated the packaging materials to allow for recycling When purchasing a packaged product, I checked that the information on the recyclability of the package was present, making sure that it was easily recyclable When buying a paper product (e.g. toilet paper, napkins, etc.), I chose the one with environmental information for recycling on the packaging When I bought bottled water, I chose the one with environmental information for recycling on the package When buying confectionery products (e.g. biscuits), I have chosen products with clear indications for separate collection	From 1 = "never" to 5 = "Always/Every time it is possible"	0.75	Testa et al. (2020)

Table 6
Measurement scales for other psychological and behavioral variables.

Latent variables	Items	Alpha	Response	Sources
Environmental Concern	I am extremely concerned about the planet's environmental situation and what it will mean for future generations Growing damage to the environment is a serious problem In our country we are not doing enough to protect the environment Currently, the environment is one of the most important issues facing the world I am very scared of the consequences of climate change on humanity Global warming is an urgent problem that needs to be addressed now Climate change poses a major threat to the well-being of humanity Water scarcity is one of the environmental problems that concern me the most Water scarcity is one of the most dangerous challenges facing the world I am very concerned about the water shortage The food sector generates very serious impacts on the environment Changing food choices towards more sustainable options should be a priority It is extremely important to reduce the impact of our food choices on the environment	0.95	From 1 = "strongly disagree" to 6 = "strongly agree"	(Jin Gam, 2011; Trivedi et al., 2018)
Circular attitude	It is important to reduce your consumption of resources to protect the environment It is useful to make sacrifices to carry out separate collection It is gratifying to give a new function to abandoned objects It is environmentally sustainable to rent products to avoid buying products that I would use once/occasionally Buying products that do not deteriorate/last a long time makes me feel that I am doing the right thing	0.68	From 1 = "strongly disagree" to 5 = "strongly agree"	Testa et al. (2020)
Appreciation of information accessibility	I feel more confident when I see that a product offers additional information (e.g., via a link to a web page), even if I don't look for it Knowing that additional product information is easily accessible (e.g., via a link to a web page) makes me less concerned about its quality The availability of easily accessible additional information about the product (e.g., via a link to a web page) increases my confidence in its adequacy, whether I check it or not Claims about additional product information (e.g., via an invitation to access a web page) make me feel more comfortable	0.88	From 1 = "strongly disagree" to 6 = "strongly agree"	Our elaboration
Use of digital information	When I buy a product in a physical store, I search the internet for product information (for example on the company website, on e-commerce sites that report reviews, etc.) When I buy a product online (for example on an e-commerce site like Amazon or on a supermarket site), I carefully read the information on the environmental characteristics of the product on the website where I make the purchase When I buy a product online, I pay close attention to the fact that there are environmental brands or certifications among the product information on the website I scan the QR-code on the products to find out more information about them I happen to scan the QR-code to know the menu of restaurants and bars I scan and use the QR-code or barcode to access more information about the environmental characteristics of a product	0.85	From 1 = "never" to 5 = "Always/Every time it is possible"	Our elaboration
Perceived Behavioural Efficacy	It is worthwhile, as an individual consumer, to make efforts to preserve and improve the environment Since every individual can have an impact on environmental issues, what I do can make a real difference Through the purchase of products made with respect for the environment, the behavior of each consumer can have a concrete positive effect on the environment and society	0.88	From 1 = "strongly disagree" to 6 = "strongly agree"	Kang et al. (2013)

such as for the constructs of "use of digital information", "appreciation of information accessibility" and "optimization" (during purchasing and post-purchasing), since we did not find existent scales in literature to measure our constructs of interest. To do this, we clearly defined, within our research group, the constructs we wanted to measure, and then drafted a first list of pertinent items. Through multiple confrontations, we refined the list and revised the text of our items to guarantee relevance, clarity, and univocal interpretation. Next, experts of the CONAI consortium and the professional survey service provider were involved in the revision process, to ensure content validity and clarity. After that, we performed a pre-test with a small convenience sample made by university students (n = 18) which allowed us to make some further improvements, collecting comments and feedback. Then we administered the items to a representative sample (n = 1000) of the Italian population aged 18–70. This was done using the opportunity of a larger previous survey conducted in September 2020 in which we also inserted our new scales to be validated. Table 6 describes the other measures and the sources.

3.4. Approach for data analysis

Following previous studies with similar purposes (Gusmerotti et al., 2019; Zomer et al., 2024), cluster analysis was deemed an appropriate method for unveiling the different approaches of companies and consumers towards the CE. Cluster analysis is effective in identifying homogeneous and mutually exclusive groups. It accounts for maximum differentiation between groups while maximizing homogeneity within groups (Hair, 2011). Thus, this makes cluster analysis well-suited for profiling companies according to their engagement in the circular transition and consumers according to their circular behavior during purchasing and post-purchasing phases.

Given that the number of clusters for both consumers and companies was not predefined, scree plots of the "Within Sum of Squares" and its logarithmic function were generated to determine the optimal

configuration (Makles, 2012). The identification of kinks in the curves led to the selection of the optimal number of clusters (refer to Appendix Cof the Online Supporting Information). For the clustering process, we employed the k-means clustering algorithm, which classifies observations to groups based on the proximity of each cluster centroid, following the approach suggested by Makles (2012).

4. Results

This section first describes the tests conducted to ensure the construct validity of the measurements in both surveys on manufacturing companies and consumers. It then presents the results of the cluster analysis and the characteristics of the identified clusters.

4.1. Measurement validity

To ensure the validity of the constructs used in both surveys, we independently conducted an exploratory factor analysis (EFA) on the data collected from manufacturing companies (Study 1) and consumers (Study 2). The EFA helped identify the underlying structure of the constructs and confirmed that the items grouped together appropriately, reflecting the intended dimensions in both surveys. For study 1, the EFA results supported the dimensionality of the constructs related to consumers behavior circularity across different phases of the product lifecycle. Similarly, in Study 2, EFA was applied to construct related to consumer behaviors such as regeneration, preservation, optimization behavior, as well as the other psychological and behavioral variables measured (see Tables 5 and 6). Results affirm the dimensionality of these variables.

To further assess the reliability and internal consistency of the constructs, Cronbach's alpha was calculated for each construct employed in both surveys. As reported in Tables 3 and in Study 1 three out of the four constructs adopted achieve an alpha value slightly lower than the recommended threshold value of 0.7 (Fornell and Larcker, 1981). Since several studies in the social science area argue that a sufficient reliability level can be achieved with values above 0.6. (Bernardi, 1994; Tinakon and Nahathai, 2012), it could be not considered as issue for this study. In Study 2, Cronbach's alpha confirmed no reliability issues, with all constructs meeting acceptable consistency standards as reported in Table 6.

Lastly, we performed the Harman's single factor test to control whether a single factor accounted for the majority of variance (Podsakoff and Organ, 1986) finding no evidence of serious common method bias and further supporting the robustness and reliability of the survey data collected (Fuller et al., 2016).

4.2. Study 1 - manufacturing companies

The cluster analysis results identified five cluster of companies based on their level of integration of circular practices across the entire product life cycle. The composition of these clusters and the cluster normalized average of variables are reported in Table 7.

Cluster 1, which represents the 35% of companies, consist of entities with the lowest normalized average for each of the analyzed construct. These companies can be categorized as "*Linear Companies*", indicating that they have not undertaken CE actions in any of the phases of the product lifecycle. As indicated by the descriptive statistics of the control variables, shown in Table 8, Linear companies are typically characterized by small size and have experienced a substantial decrease in turnover in the last three years. These organizations generally operate within local or national markets.

Cluster 2 represents the 18% of sample. These companies exhibit a positive normalized average in the procurement and in the circular design phases and can be categorized as "*Circular in Upstream*". They are more inclined to integrate eco-design principles and purchase secondary raw materials or recycled materials instead of virgin materials. It is noteworthy that there is a close relationship between a high emphasis on eco-design and the consistent procurement of circular materials. Indeed, a design aligned with CE principles requires both the reduction of virgin materials in favor of circular materials and the optimization of value during the usage and end-of-life phases of the product. Circular in Upstream companies are generally SMEs with substantial stability in turnover over the last three years. The target market of these companies is primarily within national borders.

Cluster 3 represents the 14.5% of companies and consist of entities with a strongly positive normalized average in the logistics management construct. This cluster comprises companies that can be classified as "*Logistic Oriented*" as they only prioritize aspects related to the reverse logistics, optimization of load and route in the distribution of products and in the adoption of low impact vehicles. As shown in Table 8, Logistic Oriented companies typically have a large size, consistent turnover and customers growth over the past three years. These companies tend to operate in highly competitive markets.

Cluster 4 represent about 17% of the sample and consists of companies with a strong positive normalized average in the production efficiency construct. These companies, referred to as "*Process Optimizers*", are highly oriented on waste reduction in their operations and waste valorization outside the companies' boundaries according to industrial symbiosis processes. Process optimizers are typically SMEs characterized by slightly growing turnover. The target market of these companies is typically local or national.

Cluster 5 represent the 15.6% of companies and comprises entities with a strong positive normalized average in all measures adopted to assess the level of CE implementation across the product lifecycle. These companies, referred to as "*Circular Companies*" have fully embraced circularity successfully integrating key CE principles in the procurement, design, process, and logistics. Circular Companies are typically medium to large-sized enterprises, experiencing growth in terms of turnover, number of employees, and customer base. Additionally, companies in this cluster are more likely to export products to both European and non-European markets.

4.3. Study 2 - consumers

As result of the cluster analysis, consumers were grouped into four clusters based on the extent to which they put circular behaviors into practice (Makles, 2012). Table 9 show the groups and the relative scores in each construct (normalized means) that distinguish them with respect to the actions of preservation, optimization, and regeneration, both in the purchase and post-purchasing phases. Since consumers can play a fundamental role in the transition towards a CE model this cluster analysis highlights how some consumers groups are well committed in terms of the frequency of completion of circular behaviors, while others are still unmature and need to be more involved in the circular transition.

The "Linear" consumers score lower in all the dimensions, showing a low commitment towards the adoption of circular behaviors that occur only occasionally, when perhaps they allow the satisfaction of other needs (for example optimizing the use of products at home to avoid waste). The "Purchasing preserver" are consumers that score highest on preservation during purchasing phase. For example, they are committed in the behaviors of buying second-hand products and adopting sharing practices. They are also slightly above the average engaged in the action of optimization while shopping, for example choosing products made with minimal use of materials. The "post-purchasing optimizer" consumers are more engaged in action of optimization at home (for example using efficiently the products in order to avoid waste). They are also slightly committed in some regeneration and preservation behaviors. For instance, they score slightly above the average regarding behaviors of buying products made with recycled materials and easily recyclable at the end of life as well as in exploiting products' durability and reuse. The "Circular" consumers score highest in all the dimensions, very

Table 7
Normalized average of circular economy implementation in companies.

Cluster n°	Obs.	%	Procurement	Design	Logistics	Process Efficiency
Cluster 1 – Linear Companies	505	35%	−0.801	−0.849	−0.667	−0.818
Cluster 2 – Circular Upstream	261	18.09%	**0.694**	**0.675**	−0.355	−0.388
Cluster 3 – Logistic Oriented	210	14.55%	−0.224	0.101	**1.209**	0.010
Cluster 4 – Process Optimizers	242	16.77%	−0.107	−0.195	−0.323	**0.943**
Cluster 5 – Circular Companies	225	15.59%	**1.318**	**1.237**	**1.127**	**1.263**
Total	1443	100%				

Table 8
Descriptive statistics for the companies' clusters (normalized average).

Cluster n°	Number of Employees	Turnover in the last 3 years	Employees in the last 3 years	Clients in the last 3 years	Market target	Number of Competitors
Cluster 1 – Linear Companies	−0.164	−0.128	−0.101	−0.127	−0.104	−0.102
Cluster 2 – Circular Upstream	0.018	0.035	0.008	−0.000	0.085	−0.034
Cluster 3 – Logistic Oriented	0.248	0.012	0.113	0.021	−0.058	0.148
Cluster 4 – Process Optimizers	−0.004	0.117	−0.015	0.091	−0.007	0.109
Cluster 5 – Circular Companies	0.119	0.127	0.118	0.174	0.193	0.071

frequently adopting behaviors of preservation, optimization, and regeneration of circular value both in the purchase phase and in the use phase.

The groups are transversal to socio-demographic categories. In fact, there are no significant differences in terms of age, income, gender, educational level, and size of the urban center in which they live. Therefore, the actions of preservation, optimization and regeneration of circular value and the different behaviors on which they are based cannot be explained simplistically by socio-demographic differences. Instead, the groups differ in terms of psychological and attitudinal variables and with respect to the use of information. Table 10 summarizes these variables means for each group.

"Circular" consumers show scores far above the average in all the dimensions of environmental concern, circular attitude, appreciation of further information, and use of digital information. Moreover, they perceive quite more than the other clusters, the importance, and efficacy of their individual behaviors to help the environment. In a mirror way, "linear" consumers have scores below the average for all these variables. The "purchasing preserver" consumers score above the average regarding the appreciation of the availability of further information even if they do not show high levels of effective digital information use. "Post-purchasing optimizer" show scores slightly above the average in almost all the variables: however, they show scores lower than the average with respect to the appreciation and use of digital information.

5. Discussion

Profiling manufacturing companies and consumers based on their attitudes towards circular choices reveals the synergies and divergences between demand and supply for circularity within the current production and consumption system. From a stakeholder perspective, this analysis emphasizes the interdependence between companies and consumers as key stakeholders in the CE. This study emphasizes the importance for companies of understanding the interests and influences of consumers, providing a holistic view of their mutual roles in advancing a systemic transition toward a CE. By examining both the integration of circularity in production and consumption, our findings contribute to understanding the symbiotic relationship between demand and supply, bridging the gap left by previous studies that focused singularly on one of these aspects.

After identifying the clusters of companies and consumers through cluster analysis, a general pattern emerges regarding the approach to circularity in production and purchasing choices. Three common classification levels can be identified, consisting of "Circular," "Transitioning," and "Linear" entities. "Circular" companies and consumers have implemented practices throughout the entire product value chain or adopt virtuous behaviors both in the purchasing phase and in the post-use of the product. Conversely, "Linear" companies or consumers pay little attention to circularity in all observed dimensions of production and consumption. In between, "Transitioning" companies and consumers represent entities making efforts towards circularity that are heading in a single direction. Transitioning companies emphasize circularity only in one of the phases of the product lifecycle such as in the procurement or design (i.e., Circular Upstream), in production efficiency (i.e., Process Optimizers), or in logistics (i.e., Logistic Oriented) without implementing actions holistically. Transitioning consumers are more oriented toward preserving circular value in the purchasing phase (i.e., Purchasing Preservers) or optimizing waste generation in the post-purchasing phase (i.e., Post-Purchasing Optimizers).

The heterogeneity among consumer profiles underscores the segmentation of circular demands, outlining specific actions that companies should take to meet these varied needs. From a stakeholder perspective, different consumer profiles can be viewed as different stakeholder groups with distinct expectations and demands. This perspective highlights the need for organizations to evolve in response to this heterogeneity. Specifically, the varied consumer demands for circular products, along with their emphasis on transparency and information about the product lifecycle, compel companies to innovate and adopt circular practices. In line with stakeholder view, companies must consider not only their internal objectives but also the external pressures exerted by various stakeholder groups, including consumers, to fully integrate circular principles into their strategies. Thus, to implement the actions needed for the circular transition and bridge the gap between demand and supply, companies can leverage consumer demand for circularity to enhance their efforts in the CE.

Moreover, emphasizing the dynamic and reciprocal relationship between external stakeholders (Freeman et al., 2010), such as different groups of consumers, companies also play a role in guiding demand towards more circular products (Tapaninaho and Heikkinen, 2022). Companies belonging to each of the three groups can exert influence to stimulate consumption styles aimed at preserving and optimizing resource use. Fig. 1 highlights these dynamic and reciprocal

Table 9
Normalized average of consumers behavior in purchasing and post-purchasing phase.

Clusters	Obs.	%	Purchasing phase			Post-purchasing phase		
			Preservation	Optimization	Regeneration	Preservation	Optimization	Regeneration
Cluster 1 – Linear	154	15%	−0.71	−1.02	−1.16	−0.55	−0.18	−1.07
Cluster 2 – Purchasing preserver	205	21%	**0.42**	**0.18**	−0.11	−0.34	−0.90	−0.15
Cluster 3 – Post-purchasing optimizer	348	35%	−0.39	−0.19	0.02	0.06	**0.29**	0.02
Cluster 4 – Circular	293	29%	**0.55**	**0.64**	**0.67**	**0.46**	**0.38**	**0.65**
	1000	100%						

Table 10
Descriptive statistics for the consumers' clusters (normalized average).

Clusters	Environmental concern	Circular attitude	Appreciation of information accessibility	Use of digital information	Perceived behavioral efficacy
Cluster 1 – Linear	−0.48	−0.41	−0.62	−0.62	−0.68
Cluster 2 – Purchasing preserver	−0.25	−0.26	**0.22**	−0.03	−0.29
Cluster 3 – Post-purchasing optimizer	0.03	0.08	−0.21	−0.02	0.08
Cluster 4 – Circular	**0.39**	**0.31**	**0.42**	**0.38**	**0.46**

relationships between consumers and companies, illustrating how mutual influence can close current gaps and drive a systemic transition towards a CE. "Circular Companies" implement circular practices across all stages and consistently demonstrate sustained economic growth across various business metrics. These companies have embraced a holistic vision in approaching circularity, suggesting an integrated business strategy and an organizational culture that champions circularity (Marsh et al., 2022). Their presence in both European and non-European markets reflect a global outlook and adaptability to diverse regulatory and cultural environments (Mishra et al., 2019). Given their combined circular and economic performances, "Circular Companies" serve as exemplary models and best practices for "Linear Companies" to adopt a circular approach while also enhancing their economic outcomes. Circular Companies, through their leadership in circular innovations and transparency, can serve as role models and create pressure within industries for broader adoption of CE principles. For instance, by forming strategic partnerships or creating open-source knowledge-sharing platforms, Circular Companies can help Linear Companies transition by providing best practices, technical expertise, and demonstrating the financial viability of circular strategies (Trabucchi et al., 2023; Patrucco et al., 2017). Circular Companies can also engage in collaborative projects that include Linear Companies in their supply chains, thus pushing them to adopt more sustainable practices, fostering a more systemic change within industries (Patrucco et al., 2022).

Circular Companies also play a crucial role in supporting circular behavior of both Linear and Transitioning Consumers. Considering psychological and attitudinal variables, Linear Consumers appear to be either the least informed or the least concerned about environmental sustainability. They may also face practical or psychological barriers that hinder their adoption of circular behaviors. Their scarce environmental concern and perceived behavioral efficacy support this interpretation. In this context, Circular Companies can stimulate the sustainability awareness of linear consumers by educating them about the importance of their actions and the positive impact they can individually generate (Gossen and Heinrich, 2021). In addition, circular companies can raise awareness among Linear Consumers by providing detailed guidance of how they can contribute to the circular model through proper product use and end-of-life management (Gossen and Kropfeld, 2022; Rustam et al., 2020).

Transitioning Consumers, comprising both the "*Purchasing Preserver*" and "*Post-purchasing Optimizer*", collectively account for more than half of the sample. These consumers may respectively lack the knowledge or resources to extend these behaviors beyond the point of purchase, or they might not be fully aware of or convinced about the benefits of preservation or regeneration behaviors at the time of purchase. However, the high propensity of these consumers towards the use of digital technologies, as well as their appreciation for product information, provides circular companies with a tool to further sensitize them not only towards preservation and optimization but also towards the regeneration of circular value in the purchasing and post-purchasing phases (Wang et al., 2021a). To encourage consumers to appreciate circular products, Circular companies should rely on digital communication channels with the use of more innovative forms of communication (Taufik et al., 2023).

Transitioning consumers play an active role in supporting companies' transition towards a holistic adoption of circularity. Transitioning companies, which account for half of the sample, tend to focus on refining specific value chain segments rather than embracing a holistic approach in their journey to implement the circular economy (Gusmerotti et al., 2019). Through their emphasis on optimizing circular value in the post-purchasing phase, consumers in transition can exert pressure to encourage companies towards circular procurement and design (i.e., Circular in upstream), favoring purchases of products with recycled and recyclable materials (Chi, 2022; Diddi and Yan, 2019). Moreover, by preserving circular value in purchasing through choices such as second-hand purchases, product sharing, and servitization, consumers in transition open up new market opportunities for transitioning companies (Gong et al., 2019). Grounding on stakeholder lens, the relationships between the demand and supply of circularity are not unidirectional but evolve symbiotically based on mutual needs and influences of different stakeholders. Thus, transitioning companies can benefit from the demands of circular consumers while further supporting them towards holistic circular behavior and stimulating linear consumers. For example, activating partnerships and consultations with consumers through surveys, forums, and focus groups can provide companies with insights to improve the circularity of their products offered, while also serving as a testing ground for new solutions aimed at fully engaging consumers in circular behaviors (Shevchenko et al., 2023). Further, transitioning companies can encourage consumers to approach circularity by implementing reward programs or discounts for returning old products or by providing buy-back schemes (Wang et al., 2021a).

The majority of "Linear Companies" identified in this study resonates with previous studies (Howard et al., 2022; Khan et al., 2022), highlighting the challenges faced by smaller enterprises when implementing profound alterations to their operational paradigms. However, these results contrast with most consumers identified as "Circular Consumers", who exhibit high levels environmental concern, attitudes, and

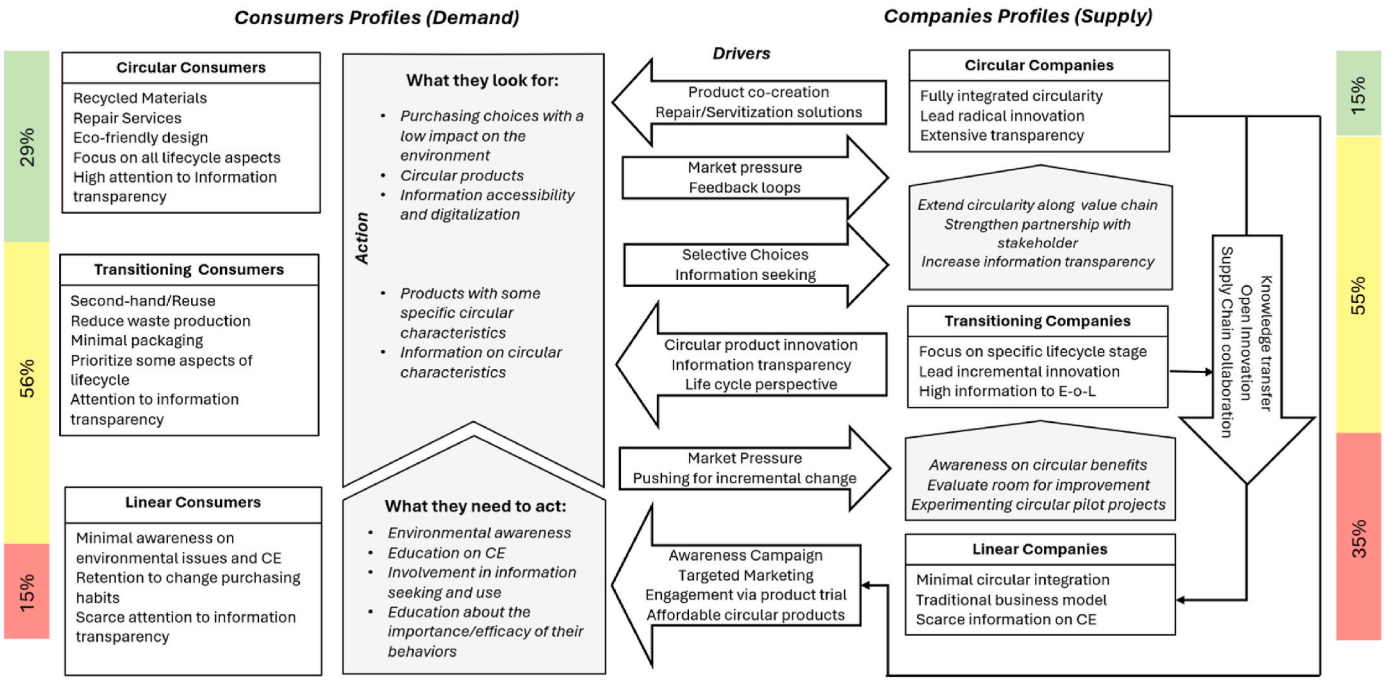

Fig. 1. Mutual influence between consumers and companies to bridge the gap between circular demand and supply.

perceiving behavioral efficacy. They can clearly discern the link between their individual actions and the broader impact that these behaviors can have in transitioning towards a CE model and overall environmental sustainability. A deeper understanding of Linear Companies profile might associate with the specific markets these companies cater to. Engaging at a local level might present distinct obstacles to adopting a circular mindset, potentially hindering the shift due to the local awareness gap on issues like sustainability and CE (Grafström and Aasma, 2021). From a consumer perspective, results emphasize the importance of not fixating on geographical or demographic variables when seeking to understand and influence consumers' circular behaviors. Despite this result contrasts with previous research (Hazen et al., 2017), which emphasized the significance of how demographic variables could affect circular economy behavior, it suggests that also at local level, consumer aware of the CE through their choices can push linear companies to adopt more sustainable practices and products over time.

The dynamic and reciprocal relationship between consumers and organizations underscores that the current gap between demand and supply in the CE must be addressed through active engagement from all stakeholders and the creation of feedback loops between producers and consumers. Purchasing behaviors that favor selective choices of circular products, alongside advocacy for greater transparency and information about circular solutions, push companies to enhance their efforts towards a more holistic approach to CE. Conversely, companies' circular initiatives, awareness campaigns on CE, and informed guidance on the transition can shape consumer attitudes and behaviors towards circular-oriented choices. This symbiotic role and mutual influence between companies and consumers is at the core of a dynamic loop that foster a systemic transition towards a CE.

5.1. Contributions and implications

This study makes several key contributions to research and theory. First, it identifies the gap between circular production and consumption and discusses how the mutual pressures exerted by companies and consumers can help bridge this gap. By extending on previous studies that have separately observed these two sides of the same coin, this study lays the groundwork for further research examining companies and consumers as a unified system, exploring how they can work together for a systemic transition. Second, by integrating the stakeholder perspective with CE research, this study emphasizes the dynamic and reciprocal relationships between consumers and companies. It shows how different consumer segments, viewed as diverse stakeholders, can influence companies to adopt and innovate circular practices. The bidirectional framework developed in this study highlights how the mutual influences between consumers and companies. This framework illustrates how consumer demands drive company actions, which, in turn, play a pivotal role in guiding a more circular demand. This framework offers a comprehensive understanding of the symbiotic relationship between companies and consumers in advancing the CE. Lastly, the study promotes a holistic approach to the circular transition, emphasizing the importance of engaging in dynamic feedback loops that drive systemic change. This approach underscores the need for comprehensive and bidirectional engagement between companies and consumers, advocating for a collaboration at multiple stages to advancing a systemic transition towards a CE.

Managerial and policy implications stem from the results of our study. First, managers should be more aware of a positive attitude of consumers towards the CE. Consequently, they should be more inclined to invest in improving their circular performance by using recycled inputs, adopting circular business model such as servitization, repairing services, industrial symbiosis initiatives, and investing in extending product life spans (De Angelis, 2022). Second, companies should invest in accessible and user-friendly product information systems that highlight circular attributes and help consumers to take decisions coherently with their values. While some recent research suggests that companies should quickly switch from traditional forms of communication to newer digital formats (Hojnik et al., 2023), our findings indicate that only 'Circular' consumers demonstrate high usage of digital information. Therefore, to encourage consumers to appreciate circular products, companies should rely on traditional communication channels and exercise moderation in their use of more innovative forms of communication. In other words, the adoption of innovative channels should be complemented with traditional ones. Lastly, managers should work to bridge the gap between circular demand and supply, by directly

engaging with consumers and gather their feedback to better understand their needs and preferences regarding circular products. This engagement can inform product development and marketing strategies that resonate with consumer values and drive circular consumption.

To better align supply and demand, policymakers may incentivize innovation in circular product design and manufacturing processes through grants, tax incentives, or partnerships with research institutions. These forms of incentive can encourage companies to invest in circular practices that meet consumers expectations. Moreover, policymakers can promote transparency by implementing regulations that require companies to disclose information about the circularity of their products. They can further support the development of user-friendly tools and apps to help consumers make informed choices. The adoption of user-friendly tools for information and transparency can help consumers make informed choices, align their purchases with environmental values, and encourage companies to move to circular business model (Trabucchi et al., 2023). Lastly, should launch public awareness campaigns to educate linear consumers about the benefits of the CE and how their purchasing decisions impact sustainability, shifting consumer behavior towards greater acceptance and demand for circular products (Wang et al., 2021b).

5.2. Limitations and avenues for future research

This study though valuable, is not devoid of limitations, which in turn serve as signposts directing future research avenues aimed at a deeper understanding of the interplay between supply and demand in the CE. First, as with most survey-based research, the reliance on self-reported data could introduce potential biases, such as social desirability, particularly in the context of environmental behaviors. Future research could benefit from employing complementary methodologies, such as observational studies, or qualitative methods like interviews and focus groups, to deepen the understanding of motivations, challenges, and barriers surrounding the demand and supply of CE. Furthermore, given the online nature of the consumer survey, there is a potential for self-selection bias, as participants with a pre-existing interest in sustainability may have been more likely to participate, potentially skewing the results toward more environmentally conscious individuals. Future studies could use mixed methods to ensure a more representative consumer sample.

Second, the study captures a cross-sectional snapshot of CE engagement, providing valuable insights into the current state of circular practices but lacking a temporal dimension. A longitudinal approach could provide valuable insights into how companies' circular practices are shaped by evolving consumer demands and, conversely, how consumers' adoption of circular behaviors is influenced by changes in corporate practices, such as product availability, communication, and marketing efforts.

Third, while this study employs substantial data gathered from a large sample of companies and consumers, it is circumscribed by its singular geographical focus, thereby rendering caution necessary when attempting to extrapolate its findings to diverse contexts. To broaden the applicability of the findings, scholars may consider extending this study beyond the Italian context.

Fourth, while this study explores the gradual process of circular transition of companies and consumers, it does not deeply consider the influence of external factors, such as government regulations or market incentives. The role of policy frameworks in driving or hindering the transition toward a CE presents an important avenue for future research, particularly in understanding how these policies affect companies of different sizes and across various industries as well as different consumer clusters.

Lastly, the study does not delve into the internal organizational dynamics that can enable organizations to transition towards circular productions, nor does it explore the behavioral dynamics that influence consumers' propensity for circular demand. Future research could explore how circular economy initiatives are integrated into operations management and organizational practices, as well as how consumers learn about circular economy paradigms and incorporate them into their purchasing routines.

6. Conclusion

This study investigates the gap between circular demand and supply by profiling consumers and companies according to their circular behavior or the adoption of circular practices. Further, we explored how the interaction between companies and consumers profiles can drive a systemic transition toward a circular economy. Data were collected from two large samples of consumers and manufacturing companies in Italy, with profiling conducted through cluster analysis.

Our findings reveal that only a small fraction of companies have fully embraced the tenets of the CE, manifesting their commitment through comprehensive actions spanning the entirety of the product value chain. In contrast, most companies are in a transitional phase, progressively integrating circular practices, albeit with a focal point on specific stages such as supply, production operations, or logistics. Among consumers, approximately 30% of the total sample can be characterized as active manifestation of circular value in both the purchase and post-purchase phases. Concurrently, a noteworthy segment of consumers is steadily adopting pro-environmental behaviors in at least one of the two critical phases essential for the effective management of circular value (i.e. purchase and post-purchase).

The findings reveal an imbalance between circular demand and supply. Consumers demonstrate a more advanced understanding of circularity, balancing functionality, cost, and environmental impact in their purchasing decisions. However, companies, while progressively adopting circular practices, still lag in fully integrating CE principles across all business functions. This gap indicates that businesses have yet to seize the full potential of circularity, often focusing on short-term gains rather than aligning economic efficiency with environmental sustainability. This highlights the need for companies to evolve their approach, adopting circular principles as core components of their strategies rather than selective practices driven by short-term economic gain. This call for a necessarily awareness that the protection of market value cannot disregard the protection of natural capital and that these two objectives must be pursued simultaneously, avoiding subordinating the latter to the former. It is only by being aware of this that a cultural evolution in consumers behavior and business strategies is possible that can lead more companies towards a full integration of CE principles into production and consumption models.

Grounding on a stakeholder perspective, this study further underscores the dynamic, reciprocal influence between companies and consumers. Circular and transitioning companies play an essential role in guiding both consumers and linear companies toward circular practices through actions like knowledge transfer, transparency, and collaboration along the supply chain. Consumers, particularly those already adopting circular behaviors, can exert pressure on companies to innovate and improve their circularity, highlighting the importance of engaging all stakeholders in a bidirectional feedback loop to close the gap between circular demand and supply. This study lays the groundwork for future research by emphasizing the importance of analyzing the interdependent roles of consumers and companies in driving the circular transition. Further studies should investigate how these stakeholder dynamics evolve across different industries and regions, exploring the mechanisms that can further accelerate the bidirectional influence between circular demand and supply.

CRediT authorship contribution statement

Filippo Corsini: Writing – original draft, Methodology. **Simona Fontana:** Project administration. **Natalia Marzia Gusmerotti:** Supervision, Writing – original draft. **Roberta Iovino:** Writing – original draft,

Software, Methodology, Formal analysis, Data curation, Writing – review & editing. **Fabio Iraldo:** Supervision. **Domenico Mecca:** Writing – review & editing, Writing – original draft, Software, Methodology, Formal analysis, Data curation, Conceptualization. **Luca Fernando Ruini:** Supervision. **Francesco Testa:** Writing – review & editing, Writing – original draft, Supervision, Project administration, Methodology, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.clrc.2024.100232.

Data availability

Data will be made available on request.

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