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(Article begins on next page)

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Exploring circular consumption: circular attitudes and their influence on consumer behavior across the product lifecycle

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Abstract

This study explores the dynamic and multidimensional domain of circular consumption, emphasizing the relevance of a lifecycle perspective in understanding consumer behaviors within the circular economy. Moving beyond prior research that predominantly focused on specific actions such as recycling or purchasing second-hand products, we advocate for a more comprehensive understanding of consumer choices throughout a product's lifecycle. Drawing on attitudes theory, we employ item response theory (IRT) models to unveil latent attitudes reflecting diverse circular consumer behaviors. These attitudes, inferred from manifested actions across different product lifecycle stages, include environmentally-centric, resource-centric, and societal-centric circular attitudes. In total, the study involves a representative sample of 5,124 respondents across five European countries. Our findings underscore the complexity of consumer motivations in the circular economy, revealing distinct links between circular attitudes and behaviors. This research contributes to a nuanced understanding of circular consumption, emphasizing the importance of a lifecycle approach, and driving the development of robust measurement scales for circular consumer actions.

Keywords: Circular Attitudes, Circular Consumption, Item Response Theory, Consumer Behavior, Attitude-Behavior link

1 Introduction

Consumers are pivotal in advancing the circular economy paradigm, fostering environmentally and socially responsible behaviors throughout a product's lifecycle (European Environment Agency, 2022). Serving as key contributors, consumers translate circular economy principles into patterns of actions spanning from purchase to use and after-use disposal. The emerging concept of circular consumption encapsulates this holistic approach, encompassing a comprehensive system of behavioral factors (Dieu-Hang et al., 2017; Kumar et al., 2017), attitudes, and value structures (De Morais et al., 2021; Gomes et al., 2022), which unfold beyond conventional "green" or "ethical" labels (Sudbury-Riley and Kohlbacker, 2016; Testa et al., 2021).

Previous research on circular consumption has primarily focused on the factors influencing specific consumer actions, such as the purchase of remanufactured or refurbished products (Bigliardi et al., 2022) recycled consumer goods (Pretner et al., 2021), "green" or "less polluting" products and services (Hosta and Zabkar, 2020; Riva et al., 2022), while overlooking consumer behaviors across other stages of the product lifecycle, such as product use and after use disposal. Moreover, literature on attitudinal drivers to circular consumption has mostly focused on environmental concerns (Testa et al., 2020), awareness (De Guimarães et al., 2023) and values (Ali et al., 2019), neglecting the influence of cultural, social, and psychological factors on circular behaviors (Singh and Giacosa, 2019).

This study advocates for a broader conceptualization of circular consumption by exploring the nature and role of individual attitudes underlying circular consumer behaviour from a lifecycle perspective.

Drawing on the theoretical foundations of attitudes and their pivotal role as antecedents of consumer behavior (Ajzen, 2001), this study conceptualizes circular attitudes as unobserved (latent) individual-level characteristics, embodying a positive disposition toward circular consumption (Bohner and Dickel, 2011). As circular attitudes manifest in various consumer actions across different stages of a product lifecycle, different patterns of observed consumer behavior are contingent upon (i.e., a function of) each individual's unobservable circular attitudes.

Within this framework, the goal of this study is to identify and develop implicit (reflective) measures of circular attitudes based on patterns of observed consumer behaviors, using latent trait analysis. Given the diverse nature and frequency of observed consumer actions throughout a product lifecycle, we adopt an exploratory approach, estimating the number of latent characteristics inductively. To achieve this, we employ a multidimensional Item Response Theory (IRT) model for graded responses, a family of latent trait models developed by research in cognitive psychology for implicit attitude measurement (Lord et al., 1968). Over recent years, IRT-based models have gained popularity for their effectiveness in assessing latent

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traits, such as attitudes, abilities, or behavioral characteristics, across different domains. In economics, these models have been utilized for detecting situations of need or deprivation (Szeles and Fusco, 2013); in medicine, for identifying complex health conditions (Prenovost et al., 2018); in marketing, for revealing purchasing tendencies (De Jong et al., 2008); and in strategic management, for capturing CSR-related attitudes within large organizations (Carroll et al., 2016).

Utilizing an IRT-based measurement approach enables us to address major theoretical and methodological limitations present in existing research. Unlike traditional attitude scales, which rely on questions about beliefs or intentions and implicitly assume the existence of latent characteristics if relevant dimensions are included in the construct, IRT models offer a reflective measurement approach. They assess how different patterns of observed consumer behavior throughout the product lifecycle may reflect different latent attitudes. Moreover, in addition to determining a continuous measure of circular attitudes at the individual level, IRT models produce estimations of item-level parameters. This facilitates the assessment of consumer actions that best characterize individuals with varying levels of the underlying attitudes (Van Der Linden and Hambleton, 2013).

The research design encompassed two field studies employing the same conceptual framework but conducted in different contexts to strengthen reliability, external validity and generalizability of the results. The first study scrutinized consumers behaviours throughout the clothing product lifecycle among the Italian population, while the second study replicated this approach across four other major European Union countries: Spain, France, Poland and Germany. The total sample consisted of 5,124 respondents, representative of the population of these countries. Behavioral patterns of these individuals were discerned through a list of 30 test items covering a variety of consumer actions in the purchase (including second-hand), recycling, sharing, use and after-use disposal stages of the product lifecycle.

Our exploratory analysis, employing a multidimensional IRT model, identified three distinct types of latent traits at the individual level: environmental-centric, societal-centric and resources-centric circular attitudes. These attitudes dictate different patterns of consumer behavior throughout the product lifecycle. Environmental-centric attitudes are manifested in rational consumption choices, characterized by gathering information on the production process, raw materials, and resource usage before purchasing a product. Societal-centric attitudes are evident in consumer behaviors that aim to maintain the product's value within the socio-economic system, such as renting, reusing repairing, and sharing. Resources-centric circular attitudes align environmental benefits with economic considerations, leading to eco-efficient behaviors such as preserving the product durability, reducing resource consumption, and minimizing waste.

The results suggest that consumers who prioritize environmental aspects also tend to value social aspects of consumption. Individuals with

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high societal-centric attitudes engage in a broader range of consumer actions compared to those with high environmental or resources-centric attitudes, which are more prominent in purchase and use behaviors. As a result, societal-centric circular attitudes play a crucial role in capturing emerging consumption models and addressing the new challenges introduced by the circular economy paradigm.

This study contributes to the field in three main ways. Firstly, it advances our understanding of circular consumption drivers (Testa et al., 2021), emphasizing the role of diverse attitudes – and associated value structures – in shaping circular consumer behavior. It provides valuable insights for policymakers and businesses aiming to promote sustainable consumption practices. Secondly, it recognizes the diverse ways individuals can contribute to a circular transition and underscores the need for future research to adopt a holistic approach to sustainable consumption. Our findings indicate that circular attitudes manifest in behavioral patterns encompassing a broad spectrum of consumer actions, extending beyond traditional purchase, recycling, or reuse, and emphasizing the relationship between circular attitudes and emerging consumption models (Patwa et al., 2021). Thirdly, the study contributes to the development of measurement scales capable of capturing the complexity of circular consumer actions (Sudbury-Riley and Kohlbacker, 2016). Our study offers a nuanced understanding of how different patterns of observed consumer behavior reflect distinct latent (circular) attitudes throughout the product lifecycle, achieved through the application of a consistent measurement instrument.

2. Literature Review

2.1 Consumer behavior in the circular transition

The necessity to transition towards a consumption and production system capable of maximizing value retention within the system while minimizing the exploitation of natural resources has underscored the potentially positive role of consumer behavior (Gomes et al., 2022; Testa et al., 2020).

Viewed through the lens of circular economy principles, consumer behavior assumes a more multidimensional and holistic connotation (Gomes et al., 2022; Geissdoerfer et al., 2017). Some authors characterize this shift as a consumption “system”, encompassing a set of activities, decisions, and behaviors that span product purchase and use to satisfy consumer needs (Sun et al., 2019; Woodside and Dubelaar, 2002). Consumer behavior encompasses the entire product life cycle, from purchasing to end-of-life stage, thereby playing a crucial role in shaping a sustainable future. By drawing on the tradition of 'R' models and waste hierarchies, more circular consumption behaviors can be identified for each consumption stage (Kirchherr et al., 2017). These stages, derived from business models and

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practices suggested in the literature (Bakker et al., 2014; Ellen MacArthur Foundation, 2013; Piscicelli and Ludden, 2016; Van Weelden et al., 2016), do not represent a hierarchy but rather a sample set of behaviors that require active involvement or initiation by consumers.

Moreover, the expanded set of choices available to consumers is accompanied by new hindrances and barriers that can make these actions more challenging (Vidal-Ayuso et al., 2023).

At the purchasing stage, consumers have a range of choices that significantly impact the circularity of a product. They can choose to re-buy items, promoting a recycling loop, or opt for renting and sharing, reducing overall resource consumption. This underscores the idea that consumers, through their choices, can contribute to the circular transition in diverse ways. However, the lack of awareness regarding the implications of such actions, difficulties in acquiring or interpreting information associated with circular options (Testa et al., 2020), and the limited availability of facilities for sharing, or renting services—factors that may vary widely across regions—(Kuah & Wang, 2020) make these choices more arduous.

During the product use stage, the role of the consumer is also essential. Retaining and properly maintaining possessions or repairing items instead of discarding them, prolongs a product's lifespan and reduces the need for new resources. Additionally, purchasing high-quality, long-lasting products encourages companies to prioritize this type of production. However, lack of information on a proper product's use or limited accessibility to repair services may significantly hinder such behaviors (Güsser-Fachbach et al., 2023).

At the end-of-use stage, consumers may engage in actions such as returning, re-selling, and recycling products. They may choose to return items at the end of their life cycle, participate in re-selling to extend the product's usability, or deliver end-of-life products to appropriate recycling loops. However, cultural diversity, problems related to accessibility of take-back systems, or recycling facilities can discourage the adoption of such behaviours (Edbring et al., 2016; Testa et al., 2021).

However, the complexity behind circular consumption behaviors arises from the fact that these diverse actions are not always harmonious (Filippas et al., 2020). For instance, the decision to repurchase conflicts with the concept of renting or sharing. The choice decision to prolong a product's lifecycle, for instance by repairing it, may conflict with the decision to buy a more efficient product. This conundrum sparks dilemmas in the minds of consumers (Ali et al., 2019; Xu et al., 2023), as they grapple with choices that align with their values, lifestyle, and the broader societal goals of sustainability. A consumer may wrestle with the decision to rent a product for immediate needs or purchase it for long-term use (Filippas et al., 2020). Similarly, the choice between retaining and repairing a product versus discarding it for an upgraded version presents a dilemma rooted in the tension between emotional attachment and technological progress (Jiménez and

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Voss, 2014; Hirschman, 1980).

In conclusion, consumers exert significant influence on the transition towards a circular economy. Their engagement throughout a product's lifecycle offers numerous avenues for contribution, albeit complicated by the challenge of aligning actions with personal values and attitudes. Moreover, the multiplicity of objectives underlying consumption behaviors, such as economic efficiency versus environmental conscientiousness, underscores the necessity for a nuanced comprehension of consumer behavior within the framework of circular consumption.

2.2 Unveiling the complexity of circular consumption: a focus on attitudes

The main theoretical contributions aimed at explaining human behaviour under a rational lens have emphasised the central role of attitudes. Attitudes can be defined as a favourable or unfavourable inclination of an individual towards an object, an action or an idea (Fishbein and Ajzen, 1975). They represent a set of beliefs, inclinations, fears, and prejudices that lead an individual's mental state to be favorable towards a specific topic (Thurstone, 1928). Within the framework of the two theories most commonly used by scholars to investigate environmentally responsible consumption, namely the Theory of Reasoned Action and the Theory of Planned Behaviour (Testa et al., 2021), attitudes play a crucial predictive role in understanding the motivations that lead a consumer to make a particular choice (Ajzen, 1991). Even within theoretical frameworks specifically exploring environmentally significant behaviour, such as the Value Belief Norm (Stern et al., 1995) and the Attitude Behaviour Context Theory (Stern, 2000), attitudes, understood as a set of norms, beliefs, and values, represent one of the main factors in explaining green behaviour.

In the domain of circular consumption, numerous studies have explored the factors influencing behaviors, revealing the intricate interplay of attitudes in predicting rational actions. At the purchase stage, attitudinal drivers have been examined, primarily focusing on environmental concerns, personal inclinations towards the subject matter, or individual values (Hazen et al., 2017; Rausch and Kopplin, 2021; Tong et al., 2023). Environmental concern stands out as a significant belief driving favorable inclinations towards circular products, such as recycled and recyclable packaging (Testa et al., 2020), sustainable clothing (Apaolaza et al., 2022). Similarly, environmental awareness, defined as knowledge about the environmental impacts of one's behavior, emerges as a significant driver in various circular purchasing behaviors, such as the selection of remanufactured smartphones (De Guimarães et al., 2023), recycled consumer goods (Di Iorio et al., 2023), less polluting products (Hosta and Zabkar, 2020), or the choice of green restaurants (Riva et al., 2022). Furthermore, some scholars have focused on

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environmental values, highlighting how high levels of such values positively influence the purchase of products such as green cars (Ali et al., 2019) or refurbished smartphones (Bigliardi et al., 2022). Numerous studies focused on further stages of the consumption lifecycle also reveal environmental-related attitudes as pivotal drivers. Empirical confirmation can be found, for instance, in the adoption of car-sharing services (Prieto et al., 2019), repair services (Fachbach et al., 2022), and product-as-service models (D'Agostin et al., 2020).

While these studies highlight the significance of environmental attitudes through deductive approaches and hypothesis testing, there is a risk of oversimplifying the complexity inherent in circular consumption behaviors. This complexity arises from the presence of diverse and multifaceted factors that can influence the adoption of circular behaviors (Singh and Giacosa, 2019). Additionally, economic needs may outweigh personal concerns about environmental degradation (Pretner et al., 2021), and conflicting environmental challenges can hinder the appreciation of circular options (Testa et al., 2022). Moreover, within each stage of a product's lifecycle, various dilemmas emerge (European Environment Agency, 2022). For instance, a consumer may choose to extend the lifespan of a product by using it efficiently or utilizing repair services. Alternatively, they may opt to purchase a new, environmentally friendly product. Furthermore, purchasing brand-new, sustainable-cotton-fibre clothing may be driven by different attitudes compared to those influencing decisions at the end-of-life stage of the product, such as swapping the garment when it nears the end of its lifespan.

Thus, the nature and frequency of observed consumer behavior throughout a product lifecycle may vary according to individual attitudes. This necessitates the adoption of an exploratory approach, wherein the number of latent characteristics is not assumed to be known beforehand and is instead estimated empirically through reflective measures. Such an approach aligns with the three-component nature of attitude as proposed by the ABC model (Breckler, 1984), which comprises affective, behavioral, and cognitive components. Although attitudes can be activated by any of these components, they tend to align in the short-term. Therefore, observing behavior allows for an understanding of the underlying individual inclinations behind the behavior. In essence, the call for an exploratory approach and the adoption of consistent measurement instruments emerges as fundamental in comprehending whether and how different patterns of observed consumer behavior throughout the product lifecycle may reflect different latent (circular) attitudes and the related value structures.

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3. Research design, data and methodology

3.1 Research design

Inspired by the methodology commonly employed in qualitative research to enhance the reliability and external validity of emerging findings (Yin, 2003), our research design was anchored in a replication strategy. We conducted two distinct field studies in separate contexts, employing an identical conceptual framework and survey design for replication purposes.

Initially, we implemented a survey-based study (Study 1) targeting a representative sample of Italian citizens. This investigation aimed to delve into the adoption of circular behaviors within a specific product category—clothing products. We selected this category due to its central role in the intricate landscape of the circular transition (Graskog et al., 2020). In the realm of clothing goods, individual consumers have the opportunity to engage in various actions contributing to the circular transition, including sharing, purchasing second-hand clothing, responsibly prolonging item lifespans, and engaging in activities like repairing or repurposing (Ellen MacArthur Foundation, 2021). This broad context of clothing items provided an ideal research setting, enabling the exploration of diverse consumer behaviors extending beyond mere purchases to encompass product use, post-use, and disposal, such as sharing, second-hand use, repair, and reuse behaviors (Testa et al., 2020). This approach facilitated the alignment of our empirical setting with the multifaceted nature of the circular economy concept (Murray et al., 2017).

Subsequently, to validate the robustness of our initial findings, we replicated the established conceptual framework by administering the same questionnaire to representative samples of consumers beyond Italy, specifically in France, Germany, Spain, and Poland (Study 2). Broadening the geographical scope of the sample from Italy to the four largest countries in the European Union allowed us to systematically evaluate the reliability of our findings in light of cultural differences across European nations.

3.2. Data collection

In both studies, we utilized the services of an independent marketing research company to administer the survey.

The sampling frame refers to the population of adult individuals (aged 18-70) in the five largest countries in the European Union, namely France, Germany, Italy, Spain, and Poland (World Bank 2020), as derived from census data from national statistical offices as of December 31, 2020[1].

[1] National Institute of Statistics and Economic Studies (INSEE) for France; Federal Statistical Office (DESTATIS) for Germany; Italian National Statistics Institute (ISTAT) for Italy; Istituto Nacional de Estadística (INE) for Spain; Główny Urząd Statystyczny for Poland.

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Probability (random) sampling was conducted with respect to three subgroups (strata) in the population of interest: age, gender, and region of residence, ensuring representativeness of the target population for each country. Data were collected by the provider in the first quarter of January 2022 on a self-administered web panel of participants, who had accepted to enroll to the survey via an e-mail link, using an incentive scheme based on credits compensation. The accuracy of the sampling procedure was validated ex post by an average sampling error of 3.5% (95% confidence interval).

While the validity of data collected through questionnaires remains a subject of extensive debate (Donaldson and Grant-Vallone, 2002), our questionnaire development process took into account potential issues associated with self-reported data (Podsakoff et al., 2003). This approach aimed to align self-reported behaviors with actual conduct, a notion supported by Cerri et al. (2019) in the context of green consumption.

The survey instrument, which focused on clothing products, was collaboratively developed by a team of five researchers with diverse backgrounds under the guidance of the first author. To create the survey, we employed a dual approach. Firstly, we grounded our measurements in an extensive review of the empirical literature. In order to assess circular consumer behaviors beyond simply purchasing new clothing items, we integrated an in-depth examination of previously validated measurement items related to sharing goods (Lang and Armstrong, 2018), acquiring second-hand products (Cervellon et al., 2012), responsibly utilizing them, repairing them to prolong their lifespan, and repurposing them for other objectives (Haines and Lee, 2021; McNeill et al., 2020; Laitala et al., 2021). Secondly, expert panels comprised of both academics and practitioners in the fashion industry participated to focus groups to discuss and enhance the content validity of the test questions. A preliminary assessment involving seven potential consumers was conducted to ensure the final adjustments aimed at enhancing the validity of the scales.

In line with the recommendations of Podsakoff et al. (2003), we implemented a set of measures to mitigate common method bias (CMB). First, we engaged potential respondents to validate the effectiveness of the procedures adopted for mitigating social desirability (King and Bruner, 2000; Tourangeau and Yan, 2007). This approach effectively prevented the inclusion of vague or complex concepts and sentences, as well as unfamiliar or ambiguous words in the formulation of questions. The questions were deliberately crafted to be simple, concise, and precise, with specific identification of behaviors to mitigate recall and potential consistency effects. As respondents were not asked to provide retrospective accounts of their attitudes and perceptions, we did not conduct an explicit measurement of an outcome variable, nor was our analysis based on a causal relationship between predictors and outcome variables which can be susceptible to CMB. Thus, in our case, this bias seemed not particularly problematic. The employment of IRT-based models for the development of indirect (implicit)

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attitudes measurement further helped addressing CMB issues (Diamantopoulos and Siguaw, 2006). One important assumption of IRT models is that item responses are independent (uncorrelated) given a person's level of a latent characteristic; this means that any existing correlation between observed responses to different items is absorbed by the latent construct. This is a common approach used to address measurement error in social psychology studies, as it allows us to directly measure presumed causes of CMB and incorporate them into the analysis (Podsakoff et al., 2024). Additional measures were employed to address acquiescence and common rater effects as sources of CMB. Firstly, we varied both scales and verbal labels across respondents. Secondly, replication allowed for temporal separation of measurement. Thirdly, anonymity was unequivocally guaranteed to reduce evaluation apprehension and social desirability bias among respondents.

3.3 Sample characteristics

The demographic characteristics of the 5,124 individual respondents are detailed in Table 2. The measurement instrument consisted of 30 items, representative of consumers' actions in different product lifecycle stages (Table 3). On the survey, each individual was asked to rate on a 5-point scale their evaluation about how frequently take a specific action (adopts a certain behavior), ranging from "1", being never, to "5" being "always, whenever I get the chance".

Table A1 (Appendix) presents information about mean item scores and standard deviation across countries and in the total sample, and a first scale reliability analysis using Cronbach's α. All α coefficients, calculated by country show an acceptable value (α_{DE}= 0.93; α_{ES}= 0.92; α_{FR}= 0.93; α_{IT}= 0.92; α_{ES}= 0.92; α_{PL}= 0.94).

INSERT TABLE 2 HERE

INSERT TABLE 3 HERE

3.4 Methodology: applying the item response theory (IRT) framework to circular consumer behavior

Item response theory (IRT) is a family of latent trait models first proposed in the field of cognitive psychology for attitude assessment (Lord et al., 1968), under the assumption that many behaviors are driven by

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processes operating outside of individual awareness (Uhlmann et al., 2012). In recent years, IRT models have become increasingly popular in many disciplines, to estimate indirect (implicit) measures of latent characteristics, such as attitudes, abilities, beliefs, or behavioral characteristics (e.g., purchasing tendency). IRT has been used in economics, for detecting situations of need or deprivation (Szeles and Fusco, 2013), in medicine, to identify complex health conditions (Prenovost et al., 2018), in marketing, for identifying purchasing tendencies (De Jong et al., 2008), and in strategic management, to capture CSR-related behavior in organizations (Carroll et al., 2016).

Typically, a measurement instrument consisting of a set of items is applied to a sample of subjects, minimizing both the individual awareness of the measurement construct and the ability to control and regulate responses, therefore avoiding social desirability biases (Antons and Piller, 2015).

The IRT framework models the functional relationship between a respondent's underlying latent trait level and an item-level stimulus, to form an expected probability of the response patterns (Chalmers, 2012:2). Specifically, an IRT model is defined by a mathematical function used to describe the conditional probability of a response to an item (indicative of an action) given the level of one (or more) individual's underlying latent characteristics (Thissen and Steinberg, 1986). Historically, IRT models have been mostly used in a confirmatory spirit, by modeling the item response probabilities as a function of known underlying latent characteristics of interest. However, IRT can also be applied in an exploratory manner, whereby the number of latent characteristics is not assumed known beforehand, and is instead estimated empirically (and tested by comparing nested models). Hence, adopting an IRT framework is crucial for studies aiming to model patterns of individuals' observable actions to inductively explore and measure unobserved (latent) traits.

In this study, we regard circular consumption attitudes (hereafter, circular attitudes) as a set of unobservable (latent) characteristics that reflect consumers' actions (behavioral patterns) in different stages of circular consumption. As a core concept of social psychology, attitudes constitute learned dispositions (Fishbein and Ajzen, 1975) that integrate individuals' beliefs, prior experiences, and resulting value structures. These attitudes guide individuals' judgments (Ajzen, 2001), thereby influencing their intentions to behave and subsequent behaviors. In the context of circular consumption, the object under evaluation is selection of different actions along the product lifecycle including buy, reuse, share, and second-hand purchasing, use, repair and after use disposal. When confronted with a set of options, individuals with different beliefs, value structures and inclinations will be more or less inclined to pursue different actions based on the value (the benefit) each action offers to them. As attitudes are reflected in the evaluative judgments of key individuals (Ajzen, 2001), diverse observed behavioral patterns will distinguish individuals with different value

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structures supporting circular attitudes.

The proposed application focuses on the relationship between patterns of observed consumer behaviors (consumers' assessments regarding different actions along the product lifecycle) and its underlying circular attitudes.

We devise a model focusing on the perceived benefit (value) that an individual (a consumer) receives from the decision to take a particular action more or less frequently (or not to take it at all), given the individual's level of one (or more) underlying latent characteristic(s) of interest. As the individual level of the latent characteristic(s) affects the probability of pursuing different types of actions more or less frequently (i.e., the probability of frequently pursuing an action *j* is influenced by the level of the latent characteristic(s) of an individual *i*), the IRT-based measure of each latent characteristic is conceived as an indicator reflecting individuals' evaluations of the costs/benefits of pursuing different actions[2].

In addition to determining a continuous measure of the latent characteristic(s) of interest, (i.e., each individual's position along the latent traits *continuum*), the IRT model produces estimations of item-level parameters, enabling to evaluate test questions (i.e., to assess of the types of items that better qualify respondents with high and low levels of the underlying latent characteristics) (Van Der Linden and Hambleton, 2013). In this context, the probability that an individual adopts a specific behavioral pattern is conditional upon (i.e., a function of) its unobservable level of the latent characteristic(s) epitomizing circular attitudes. Therefore, it is assumed that each individual's position along the *continuum* of each latent characteristic of interest) will epitomize the level of the individual's attitude resulting from their value structure.

The data input into the model consists of n=5,124 individuals' response patterns of graded scores for the 30 items, measuring the frequency of a set of consumer actions along the lifecycle (Table 3).

We specify an IRT model for graded responses (IRT-GRM) using the graded scores for each item that include four categories k=0; k=1; k=2; k=3)[3].

Table 4 reports the frequency of item responses in the sample.

INSERT TABLE 4 HERE

[2] Such an exploratory analysis of circular behavior in terms of the underlying decision process is strongly consistent with extant research examining the determinants of consumer behavior through the use of reflective measures (see, e.g., Sudbury-Rielly and Kohlbacher, 2016).

[3] To be input in the IRT graded response model, the item responses were re-codified in a 4-points ordinal scale, "0" being "I never or rarely took this action", and "1"- "2"- "3" being "sometimes", "often", and "always, whenever I get the chance", respectively.

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Under the IRT framework, the individual's subjective evaluation of taking different actions with higher or lower frequency is conditional on the level of the individual's latent characteristic(s) of interest. The IRT-GRM is therefore specified for the probability that a response of category *k* or higher will be observed (Samejima, 1969).

Specifically, the probability that an individual *i* will provide a response corresponding to the k^{th} category of item *j* (π_{ijk}) (i.e., the probability that the i^{th} individual will take a j^{th} action more or less frequently) is computed as the probability of observing a response above the lower boundary of the category ($\pi *_{ij,k}$) minus the probability of observing a response above the upper boundary of the category ($\pi *_{ij,k+1}$):

$$\pi_{ij,k} = P\left(Y_{ij} = k \middle| \theta_i\right) = \pi *_{ij,k} - \pi *_{ij,k+1} \quad (1)$$

$$\theta_i \sim N(0,1)$$

Where:

$$\pi *_{ij,1} = 1, \qquad \pi *_{ij,k+1} = 0$$

$$P\left(Y_{ij} \leq k \middle| \theta_i\right) = \frac{\exp\left(\alpha_j \theta_{i-k_{j,k}}\right)}{1+\exp\left(\alpha_j \theta_{i-k_{j,k}}\right)} \quad (2)$$

We adopted an exploratory approach, whereby no prior knowledge of the latent structure (the relationship between items and latent characteristics) is included in the model, and the number of dimensions is not assumed known beforehand. The dimensionality of the latent characteristic(s) is instead estimated empirically by comparing nested models (Bock and Aitkin 1981). To this aim, we utilized a multidimensional item response theory (MIRT) model, where latent characteristics are allowed to correlate[4].

The multidimensional formalization of IRT models for graded responses (MIRT-GRM) is developed as an extension of the unidimensional version, where the response pattern for an individual *i* to *j* items (Z_{ij}) is an

[4] MIRT is a methodology that has been developed with the principal aim of dealing with the situation of complexity in psychological measurement when several latent characteristics influence the individual's response on each item (Reckase, 1997). By introducing a person trait and item discrimination parameters for each latent characteristic measured by a test item, MIRT models permit separate inferences with reference to each distinct latent dimension of an individual (Ackerman, 1994).

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underlying unobservable variable that is manifested in a vector of observed ordered item responses $Y_i = (Y_{i1}; Y_{i2}; \ldots; Y_{in})$.

MIRT-GRM models Z_{ij} as a linear combination of a vector of *m* individual-level latent traits $\theta_i = (\theta_{1i}; \theta_{2i}; \ldots; \theta_{mi})$, and a vector of *v* item-level parameters $\alpha_j = (\alpha_{j1}; \alpha_{j2}; \ldots; \alpha_{jv})$:

$$Z_{ij=}\alpha_{j1}\theta_{j1} + \alpha_{j2}\theta_{j2} + \cdots + \alpha_{jv}\theta_{jm} + \varepsilon_{ij} = \alpha_j'\theta_j + \varepsilon_{ij} \qquad (3)$$

Where ε_{ij} is an unobserved random variable that is assumed to be distributed as $N(0, \sigma_j^2)$.

The output of the model consists of three types of estimates.

1) Individual-level estimates. At the individual level, θ_i is the vector of latent characteristics of interest estimated as continuous measures. The IRT model assumes that the higher the level of each latent characteristic for an individual *i* (θ_i) is, the higher the probability that the individual *i* will pursue a given pattern of behavior more frequently as well.

2) Item-level estimates: *discrimination parameters*. At the item level, the vector of discrimination parameters α_j for each action *j*, conditional to the underlying level of the latent characteristic (θ_i) informs about each item's properties within the construct. If α_j, is positive, then individuals with higher levels of the latent characteristic(s) are more likely to take the action *j*; if α_j is negative, then individuals with higher levels of the latent characteristic(s) are less likely to take the action *j*. Thus, discrimination parameters α_j allow to assess if and how much each item in the proposed scale (each type of consumer's action) can discriminate individuals with higher levels of θ_i from individuals with lower levels of θ_i, thus revealing the strength of each item in explaining each latent characteristic. In the context of this study, IRT discrimination parameters allowed us to assess how different sets of consumer actions 'map' onto one or more latent characteristic(s) of interest and their comparative relevance in discriminating consumers with different levels of the latent characteristic(s) in different lifecycle stages.

3) Item-level estimates: thresholds. A second set of item-level estimates, threshold parameters (k_{jk}), are associated with the k^{th} category of each item, *j*, and model the unobservable response process Z_{ij} according to the psychological mechanism under study. Such parameters represent the likelihood that an individual will take a particular action conditional upon its level of θ_i. In our model, and for each item, this probability *k* is estimated according to three thresholds: $k_{(0\text{-}1)} < k_{(1\text{-}2)} < k_{(2\text{-}3)}$. As k_{jk} increases, all individuals are more likely to take the specific action frequently, while as k_{jk}

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decreases, only individuals with a particular level of the latent characteristic(s) will take the specific action frequently. Thus, threshold parameters inform about the position of each item along with the measures of the latent traits.

The simultaneous estimation of individual-level measures of the latent characteristic(s), and item-level parameters allows for the investigation of the relationship between specific patterns of observed behaviors and differences among individuals along the attitude(s) *continuum*. Discrimination and threshold parameters enable the researcher to assess the content validity of the test questions (i.e., to evaluate the types of behaviors that better qualify respondents with high and low levels of the underlying characteristics of interest within the proposed scale) (Van Der Linden and Hambleton, 2013). Furthermore, the possibility to relate individual-level characteristics (θ_i), to item-level characteristics (α_j and k_{ij}) enables the researcher to develop a nuanced, theory-based interpretation of the latent constructs.

4. Results

The *mirt* package in the R environment (Chalmers, 2012) was utilized for estimating MIRT-GRM parameters for our exploratory model using maximum-likelihood methods. The model utilizes an expectation–maximization (EM) algorithm, using the Gauss-Hermite quadrature as an iterative method to find (local) maximum likelihood or maximum *a posteriori* estimates of parameters, given the model depends on unobserved latent variables (Bock and Aitkin 1981; Cai, 2010).

To assess the dimensionality of the latent constructs, we empliyed an iterative approach by running MIRT-GRM models with progressively one, two, and three exploratory dimensions, and examined the improvements of goodness-of-fit statistics for nested models (see Tables 5-6). The model fit statistics validated the assumption of multidimensionality of the construct (circular attitudes), suggesting a three-dimensional model be a good fit.

INSERT TABLE 5 HERE

The choice was informed by the notable enhancements observed in the AIC and BIC statistics for the three-dimensional model compared to the two-dimensional and the unidimensional (confirmatory) models, with smaller values representing better fit (Hu and Bentler, 1995).

INSERT TABLE 6 HERE

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Furthermore, the goodness-of-fit statistics confirmed that the Root Mean Square Error of Approximation (RMSEA), used for assessing the goodness of approximation and model selection, and the Standardized Root Mean Squared Residual (SRMSR) statistic for the three-dimensional model fell below the cutoff threshold established by Maydeu-Olivares and Joe (2014). This indicates a close fit (RMSEA<0.05) and adequate fit (SRMSR<0.05) of the three-dimensional model. Finally, the lower value of the limited information test statistic (M2 statistic) by Maydeu-Olivares and Joe (2006), affirmed a better approximation of the three-dimensional model across all levels of association of the discrete variables (RMSEA2).

INSERT TABLE 7 HERE

Table 7 presents the estimates of item-level discrimination parameters (α_{jv}), the thresholds (k_{jk}), and their relationship with the three latent dimensions (where v= 1 on θ_1, v=2 on θ_2, and v=3 on θ_3). Specifically, the discrimination parameters (α_{jv}) indicate the capacity of an item *j* to distinguish individuals with varying levels of θ_1, θ_2 or θ_3. As the value of the discrimination parameters (α_{jv}) increases, the item's capability to differentiate individuals with high and low levels of the latent dimensions also increases.

4.1. Environmental-centric circular attitude

The first group of items shows the highest values of item discrimination parameters concerning θ_3 (α_{j3}). The interpretation of the latent characteristic is derived from the significance of this particular set of items. Specifically, the analysis of item-level discrimination parameters allows for an assessment of the "informative power" of each item in distinguishing individuals with higher levels of θ_3 from those with lower levels of θ_3, thus elucidating the types of actions that define θ_3.

Individuals with higher levels of θ_3 are inclined to a) select garments with minimal environmental impact during production ($\hat{\alpha}_{I6,3} = 2.853$), b) opt for garments with labels demonstrating the ethical behavior of the manufacturer ($\hat{\alpha}_{I8,3} = 2.472$), c) purchase garments made with minimal water usage ($\hat{\alpha}_{I2,3} = 2.469$), d) prefer garments made from fibers produced using environmentally friendly methods ($\hat{\alpha}_{I3,3} = 2.370$) or recycled materials ($\hat{\alpha}_{I4,3} = 2.059$), and e) avoid purchasing garments made in countries with exploitative working conditions ($\hat{\alpha}_{I9,3} = 2.019$). Given that these consumer actions are the most informative items for θ_3, we interpret θ_3 as an attitude stemming from individual value structures that assign high importance (value) to the environmental impact of consumption.

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Our findings further indicate that the actions distinguishing individuals with high levels of θ_3 are primarily associated with the purchasing stage. This attitude is evident in observed patterns of rational consumption choices focused on gathering information on the production process, raw materials, and environmental resource usage. In essence, individuals with high levels of θ_3 represent a "social circle" guided by a strong set of values and beliefs that underscore the significance of safeguarding the natural environment through the selection of products with lower environmental impact during the purchasing stage. This interpretation is reinforced by the high discriminating power of items I11, I12 and I7 on θ_3 (consumers with high levels of θ_3 purchase clothes with sustainable packaging, made from reused materials, and locally produced). Consequently, θ_3 epitomizes individuals' environmental-centric circular attitude (θ_{ENV}).

4.2. Societal-centric circular attitude

Another set of items demonstrates the highest discrimination power among individuals concerning θ_1 (α_{j1}). Individuals with a high level of θ_1 are inclined to a) rent clothes instead of purchasing them ($\hat{\alpha}_{I14,1} = 2.866$), b) purchase original vintage clothing ($\hat{\alpha}_{I17,1} = 2.037$), and/or second-hand modern clothing ($\hat{\alpha}_{I16,1} = 1.627$), c) engage in clothing exchange with others ($\hat{\alpha}_{I15,1} = 1.958$), d) customize/repair clothes ($\hat{\alpha}_{I30,1} = 1.989$), e) sell clothes to acquire others ($\hat{\alpha}_{I27,1} = 1.748$), and/or f) pass used clothing items to family members or relatives ($\hat{\alpha}_{I28,1} = 1.435$).

Consequently, θ_1 represents a latent attitude that manifests in consumer behaviors related to renting, reusing (rather than purchasing new items), repairing/customizing clothes, and sharing and/or exchanging them, across different stages of the lifecycle (from purchasing to after use-disposal). This attitude is evident in observed patterns of social behavior, as individuals with high levels of θ_1 perceive consumption not as an individual pursuit but as a social process. Therefore, we conclude that θ_1 characterizes "social circles" of consumers who give importance to the social dimension of circular behavior, focusing on preserving the product's value within the socio-economic system. Accordingly, we conceptualize, θ_1 as a societal-centric circular attitude (θ_{SOC}), seemingly typifying customer segments aligned with the new business models emerging in the circular economy paradigm (Lüdeke-Freund et al., 2019).

4.3. Resources-centric circular attitude

A third set of items demonstrates the highest discriminatory power among individuals concerning θ_2 (α_{j2}). This behavioral pattern characterizes consumers who highly value the economic benefits of circular behavior, focusing on resource preservation and waste reduction. In this case, nearly all items in the use stage are significantly important in distinguishing individuals with higher levels of θ_2 from those with lower levels of θ_2. These

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individuals tend to a) wash clothes at low temperatures ($\hat{\alpha}_{I9,2} = 1.648$), b) avoid using dryers or ironing clothing when possible ($\hat{\alpha}_{I22,2} = 1.467$), c) pay attention to garment labels directions for washing ($\hat{\alpha}_{I21,2} = 1.395$), d) wash clothes with mild or natural detergents ($\hat{\alpha}_{I20,2} = 1.271$), and/or e) attempt to reduce the number of washes ($\hat{\alpha}_{I18,2} = 1.195$). These significant actions reflect a latent attitude indicating "social circles" of individuals characterized by value structures where environmental benefits align with economic considerations, thus embodying a resources-centric circular attitude (θ_{RES}). These individuals are guided by values and attitudes that give equal importance to economic and environmental considerations, leading them to adopt eco-efficient behaviors.

Figure 1 offers a visual representation of the results in the proposed theoretical model.

INSERT FIGURE 1 HERE

The second set of item-level parameters (thresholds, k_{jk}) is estimated based on individuals' responses to the 30 items. Following an exploratory approach, our model does not assume which of the item responses is related to each of the three latent constructs (i.e. it has no *a priori* knowledge of the latent structure). Item-level thresholds can reflect the "criticality level" of each specific consumer action. Higher levels of "criticality" (higher values of the threshold parameters) correspond to lower probabilities of observing responses in higher categories (lower probabilities that an action *j* is taken frequently). This means that actions characterized by higher values of the threshold parameters are taken by more individuals in lower frequency and are, therefore, less "critical". As for the MIRT-GRM model, it is not possible to unambiguously order the items by the response probability based on the threshold parameters. To compare the probabilities of observing a response in each category of an item, we fix $\hat{\theta}_1$, $\hat{\theta}_2$ and $\hat{\theta}_3$ at the mean value of 0 and use threshold parameters (Martelli, 2014).

The results indicate that an individual with an average value of circular attitudes ($\hat{\theta}_1$=0, $\hat{\theta}_2$=0 and $\hat{\theta}_3$=0) is more likely to engage in frequent actions related to reusing, sharing and repairing clothes (indicative of societal-centric attitudes) and to buy clothes made from recycled materials or made with little use of water (indicative of environmental-centric attitudes) rather than, for instance, taking frequent actions related to "sustainable use", such as washing clothes at low temperatures or reducing the number of washing (indicative of resources-centric attitudes). Interestingly, as shown in Table 6, the values of the thresholds $k_{(1-2)}$ and $k_{(2-3)}$ for items related to reuse (I12-I13), sharing (I14, I15), second-hand purchasing (I16, I17) and those related to purchase of garments made with little use of water (I2) or from

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recycled materials (I4) are regularly lower than those for items related to consumer choices in the purchase stage (I1, I3, I5, I10) and the use stage (I18-I22), which are supported by a higher availability of information (e.g. labels or QR codes). This implies that, for individuals with average circular attitudes, environmental and societal-centric attitudes, which become manifest in renting, exchanging clothes in the stage of purchase and product disposal, and in recycling, reusing, sharing, and repairing clothes in the stage of after-use, are more relevant than resources-centric circular attitudes, translating into actions involving a responsible use of resources.

The ex-post estimated correlation among the three latent characteristics is consistent with the described results (Table 8).

INSERT TABLE 8 HERE

The value of the correlation coefficient between θ_{SOC} and θ_{ENV} is high ($\hat{r}_{SOC,ENV} = 0.574$), indicating a strong and positive association between individual attitudes emphasizing the social aspects of consumption and those prioritizing environmental considerations. This suggests that environmental-centric attitudes and societal-centric attitudes better reflect patterns of consumers' actions across various stages of circular consumption, including purchase, recycling, reusing, sharing, and repairing (circular attitudes), compared to resources-centric attitudes. A lower but still significant association is observed between environmental-centric attitudes and resources-centric circular attitudes ($\hat{r}_{RES,ENV} = 0.357$). Individuals with high levels of such attitudes tend to take action primarily in the phases of purchase and use of the products.The association between resources-centric attitudes and societal-centric attitudes is positive but weak ($\hat{r}_{SOC,RES} = 0.054$), indicating that the coexistence of the two attitudes is not widespread across individuals. This is also supported by the different patterns of actions that such attitudes reflect (purchase vs. recycle, reuse, sharing, repairing, and after-use disposal).

These findings are further supported by reliability tests conducted to check the internal and external validity of the proposed constructs[5] (See

[5] The specification of the exploratory MIRT model follows many of the rules in the structural equation modelling (SEM) framework for exploratory FA. However, one important assumption of IRT models is that item responses are independent (uncorrelated) given a persons' level of a latent characteristic; it means that any existing correlation between observed responses to different items are absorbed by the latent construct. Thus, compared to other techniques based on classical test theory (as, for instance, Cronbach alpha's test), IRT measures show higher reliability. Each construct's internal validity is assessed conditional on the scores of the estimated latent construct. For the same reasons, the use of MIRT yields also much reliable parameter estimates in small samples.

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Appendix B for details).

5. Discussion

This study inductively identified and examined three latent attitudes underlying patterns of consumer behavior that align with the lifecycle principles of the circular economy paradigm.

In this context, the application of an IRT framework allowed for the development of implicit measures of circular attitudes, capturing the perceived benefits (value) that consumers derive from specific actions across different stages of the product lifecycle. Using a multidimensional IRT model and adopting an exploratory approach, we modeled the consumer decision-making process to reflect individual-level latent attitudes. This provided insights into the relationship between consumers' latent attitudes and their underlying value structures and observed behavior.

By acknowledging the relevance of a lifecycle perspective in understanding the role of consumers within the circular economy paradigm, our findings validate the assumption that circular attitudes should be conceptualized as multidimensional constructs. The exploratory IRT analysis reveals three distinct individual-level latent traits (θi), representing environmental-centric (θ_{ENV}), societal-centric (θ_{SOC}), and resources-centric (θ_{REC}) circular consumer attitudes. These attitudes determine significantly distinct patterns of consumer behavior across throughout the product lifecycle. The item-level estimates for the three latent constructs illustrate the behavioral patterns reflecting the three attitudes at different stages of circular consumption.

The environmental-centric attitude drives sustainable purchasing decisions, as consumers with high levels of the latent trait are particularly attentive to information on the product and tend to prioritize low environmental impact, fair working conditions and "green" production processes in their selection choices, also extending these considerations to packaging. The societal-centric attitude drives extended consumer actions throughout the product lifecycle, emphasizing activities such as renting, repairing, sharing, reusing, donating, selling, and exchanging as indicative of individuals attributing value to consumption as a social process. The resources-centric attitude predominantly shapes consumer behavior during the product use phase, focusing on actions to maximize durability and minimize resources consumption, thereby determining consumers' eco-efficient behaviors.

Our results also suggest that individuals tending to value the environmental aspects of consumption (i.e., those who exhibit high environmental-centric attitude) also prioritize the social aspects of consumption (high societal-centric attitude). Furthermore, we identify a high societal-centric attitude in patterns of consumer actions that span from the

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purchase stage to recycling, reusing, sharing, repairing, and, more broadly, to after use disposal, where environmental-centric and resources-centric circular attitudes, are better reflected in product purchase and use behaviors. Based on these considerations, we conclude that societal-centric circular attitudes are those who best capture the emerging models of consumption and the novel challenges introduced by the circular economy paradigm.

This study contributes to the current academic discourse on circular consumption in several ways.

Firstly, the study expands upon previous research in the domain of circular consumption, which has primarily relied on deductive approaches and predominantly focused on environmental attitudes, values or concerns as predictors of circular consumer behaviour (Hazen et al., 2017; Raush et al., 2021; Tong et al., 2023). Given that the nature and frequency of observed consumer behavior throughout a product lifecycle may vary according to individual attitudes, adopting an inductive approach enabled us to identify diverse and multifaceted attitudes that can influence the adoption of circular behaviors, thus providing insights into the multifaceted and complex nature of circular consumption. (Singh and Giacosa, 2019)

Secondly, the study adds to literature on circular consumer behavior, by emphasizing the relationship between consumer circular attitudes and emerging consumption models, involving sharing, reusing, reselling, and second-hand purchasing. Our findings underscore that societal-centric circular attitudes play a pivotal role in extending resources-centric and environmental-centric attitudes toward circular consumer behaviour.

Further, the study adds to the ongoing discussion on the development of reflective measures when investigating sustainable consumer behavior (Sudbury-Riley and Kohlbacker, 2016; Hosta and Zabkar, 2020). While our study did not aim to develop a measurement scale and, therefore, did not follow the required procedure (Hinkin, 1995), the application of IRT-based models contributes to further improvements in current measurement approaches. Adding to the individual-level, continuous measures of the three latent attitudes, the study provided item-level estimates of the accuracy of item scales, capturing the multidimensional (and complex) nature of circular consumer behavior.

The findings of this study hold significant implications for both managerial decision-makers and policymakers. From a managerial perspective, understanding consumers' attitudes throughout the product lifecycle is crucial for analyzing their experiences and addressing their needs at different stages, from purchase to post-product use. Designing products that cater to a broader spectrum of consumer needs, based on knowledge of their latent attitudes, can enhance customer satisfaction while substantially contributing to the circular transition of products. By acknowledging the diverse ways individuals can contribute to a circular transition, the study is also relevant for businesses aiming to promote sustainable consumption practices.

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Policymakers can also derive significant benefits from this research by gaining valuable insights into strengthening the role of consumers in the circular transition, which poses ambitious and intricate challenges. Recognizing the diverse attitudes that influence consumer decisions throughout a product's lifecycle should prompt policymakers to develop tools that assist consumers in evaluating different alternatives. For instance, regulating how information is reported within products could be a promising avenue. Initiatives such as the European Commission's eco-design for sustainable products and efforts to substantiate green claims represent positive steps forward. Specifically, proposals for mandatory labels tailored to specific product categories, along with clear guidelines for formulating green claims, could be developed to support circular behavior at different stages, reinforcing the contribution of individuals to the circular economy paradigm.

5. Concluding remarks, limitations and future research

Drawing on the theoretical foundations of attitudes, this study explored the complexity of circular consumer behavior across a product lifecycle and identified three different types of attitudes (and related value structures) influencing individuals' decision processes: environmental-centric, societal-centric, and resources-centric circular attitudes. By adopting an inductive approach and a reflective measurement instrument through IRT models, the study explicitly focused on the attitude-behavior link in circular consumption.

Compared to prior research, mostly focusing on environmental-centric consumers' attitudes, and consequently related to specific patterns of consumers' actions, (such as purchase and use) the study advances current knowledge of the multidimensional nature of the circular economy paradigm. It involves a wider spectrum of consumers' decisions, and offers several alternatives to contribute to the efficient utilization of resources across the product lifecycle thus promoting the circular transition of products.

Our findings emphasize the relevance of societal-centric attitudes beyond environmental-centric attitudes in determining patterns of circular consumer behavior, and underlines the types of behaviors pursued by consumers with different (and partially overlapping) value structures.

As the consumer is a central actor in the emerging circular economy paradigm, and attitudes are learned dispositions that are consistent through time, the study may lay the basis for sustainability managerial and policy practices aimed at providing targeted information to different types of customers, and at different stages of the product lifecycle.

Our study is not exempt from limitations, which offer insights for future research.

A first limitation of the study is its focus on the clothing product lifecycle. While examining the clothing lifecycle provides valuable insights into consumer behavior and waste generation across different stages common

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to other product categories -such as raw material extraction, production, distribution, consumption, and disposal—it is important to acknowledge that other product lifecycles may present unique dynamics. Therefore, future research should broaden its scope to encompass a wider array of product lifecycles and industries. By identifying circular attitudes across diverse contexts, researchers can gain a deeper understanding of the diverse manifestations of circular attitudes at different stages of various product lifecycles.

Second, due to its exploratory and inductive nature, this study serves as an initial step towards further theory development efforts. To this end, our interpretive arguments about the nature and role of attitudes shaping circular consumer behavior should be further substantiated with rich qualitative evidence collected from groups of consumers. Future research directions should focus on understanding the mechanisms underlying the attitude-behavior *nexus* in circular consumption and, more broadly, further clarifying the consumer contribution to the circular transition of products.

Third, while our original methodological approach allowed us to identify three distinct types of circular attitudes and assess the predominant attitude(s) underlying different patterns of consumer behavior, the study did not pursue an in-depth exploration of their interaction. Future research could delve into how the interaction of distinct circular attitudes reflects different consumer behavior and specifically the potential conflicts, contrasts, and dilemmas experienced by consumers when choosing among alternative circular behaviors. Experimental research could be designed to identify how priorities are defined based on this interaction and which creative solutions are stimulated by their awareness of such tensions.

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Francesco Testa: Conceptualization (equal); Investigation (equal); Data curation (equal); writing -original draft (equal); review and editing (equal); **Cristina Marullo:** Conceptualization (equal); Methodology (lead) Formal analysis (lead) writing -original draft (equal); review and editing (equal); **Natalia Marzia Gusmerotti:** Conceptualization (equal); Funding acquisition (lead); Investigation (equal); Data curation (equal) review and editing (equal); **Vinicio di Iorio:** Investigation (equal); writing -original draft (equal)

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Tables

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TABLE 1 – Summary of the literature investigating the attitude-behavior nexus in circular consumption

Reference	**Theoretical framework**	**Context of study**	**Research method**	**Circular Behavior**	**Measurement of Attitude**	**Number of items**
Hazen et al., 2017	Push-Pull-Mooring Theory	University students in the business college of a large US university Sample of US population	Survey	Buying remanufactured laptops	Attitude toward remanufactured laptops	3
Rausch and Kopplin, 2021	Theory of Planned Behavior	Sample of German online shoppers	Survey	Purchase of sustainable clothing	Attitude towards sustainable clothing	3
Tong et al., 2023	Theory of Planned Behavior; Motivation,Opportunity and Ability model	Sample of residents over the age of 18 from major cities in Zhejiang Province (China)	Survey	Fresh berry consumption behavior.	Pro-environmental attitudes	3
Testa et al., 2020	Theory of Planned Behavior; Attitude-Behaviour-Context Theory	Representative sample of Italian population (age 18-70)	Survey	Purchase of circular packaging	Environmental concern	5
Apaolaza et al., 2022	Social Identity Theory	Representative sample of Australian consumers.	Survey	Purchase of sustainable clothing	Environmental concern	4
De Guimarães et al., 2023	*Own conceptual framework*	Sample of Brazilian consumers	Survey	Purchase of remanufactured smartphone	Environmental Awareness	4
Di Iorio et al., 2023	Theory of Planned Behavior; Attitude-Behaviour-Context Theory	Representative sample of Italian population (age 18-70)	Survey	Lifecycle Ecologically Minded Behavior	Perceived consumer effectiveness	3

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Hosta and Zabkar, 2020	Theory of Planned Behavior	Sample of Slovenian consumer	Survey	Purchase of Energy efficient, recyclable, eco-products, socially responsible products	Environmental Concern	4
Riva et al., 2022	Theory of Planned Behavior	Restaurant customers in Dhaka and Chottogram (Bangladesh)	Survey	Restaurant revisit	Green consumerism	5
Ali et al., 2019	*Own conceptual framework*	Chinese and German customers of BMW brand.	Survey	Purchase of green luxury cars	Cultural values (Horizontal/Vertical Individualism vs. Collectivism)	16
Bigliardi et al., 2022	Theory of Planned Behavior Attitude-Behaviour-Context Theory	Sample of engineering students of an Italian university	Survey	Purchase of refurbished smartphones	Collectivism	4
Prieto et al., 2019	*Own conceptual framework*	Sample of licensed European car owners in three urban areas (London, Madrid and Paris)	Survey	Adoption of car sharing services	Environmentalism	7
Fachbach et al., 2022	*Own conceptual framework*	Sample of residents in Styria (Austria)	Survey	Use of repair services	Environmental concern	6

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1 TABLE 2 – Sample Characteristics

		IT	DE	ES	FR	PL	Total
	N	**1,053**	**1,018**	**1,016**	**1,012**	**1,025**	**5,124**
Gender [%]	F	50.3	49.4	50.2	50.8	50.7	50.3
	M	49.7	50.6	49.8	49.2	49.3	49.7
Age group [%]	18-24	10.2	10.7	10.5	12.6	10.2	10.9
	25-34	16.0	19.1	16.6	17.9	20.0	17.9
	35-44	19.8	17.3	22.2	19.0	22.6	20.2
	45-54	23.7	20.9	22.7	20.5	17.8	21.1
	55-70	30.3	32.0	27.9	30.0	29.4	29.9
Income class [%]	very low	2.7	2.9	1.7	5.8	1.3	2.9
	low	7.1	6.0	3.9	14.7	4.5	7.2
	medium-low	22.6	20.5	22.0	17.4	20.8	20.7
	medium	50.9	38.3	51.9	35.3	47.1	44.8
	medium-high	13.5	22.2	16.0	18.8	17.0	17.5
	high	0.9	5.2	2.6	5.2	4.8	3.7
	very high	0.8	2.8	1.0	1.4	3.5	1.9
	N/A	1.6	2.1	0.9	1.4	1.1	1.4
N. family members	1	12.0	30.3	13.2	22.5	11.0	17.7
	2	24.0	35.3	29.5	34.7	28.1	30.3
	3	31.8	18.3	31.2	20.4	29.3	26.2
	4	21.7	9.9	19.5	14.1	18.5	16.8
	5+	10.4	6.3	6.6	8.3	13.1	9.0
Civil state [%]	Single	30.0	36.4	26.6	30.9	24.2	29.6
	Involved (not co-habiting)	10.5	8.2	6.8	7.1	10.1	8.6
	Involved (co-habiting)	15.8	13.2	16.4	13.0	25.6	16.8
	Married (not co-habiting)	8.2	12.0	8.2	8.4	6.9	8.7
	Married (co-habiting)	35.5	30.3	42.0	40.5	33.2	36.3
Town size [% residents]	< 10.000	17.5	20.9	13.6	39.0	16.2	21.4
	10.000-30.000	23.2	19.1	16.5	19.9	16.7	19.1
	30.000-100.000 ì	26.1	21.3	17.7	17.6	21.3	20.8
	100.000-250.000	11.2	13.7	17.3	11.6	15.1	13.8
	250.000-500.000	6.5	7.7	11.9	3.6	12.3	8.4
	> 500.000	15.6	17.4	22.9	8.4	18.4	16.5

2

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TABLE 3 - Scale items

ITEM	Description
I1	I choose the highest quality clothes available and durable over time
I2	I buy garments made with little use of water
I3	I prefer buying clothes made from fibers produced through low environmental impact methods
I4	I buy clothes made from recycled materials
I5	I prefer buying clothes made from natural fibers
I6	I choose garments that have a low environmental impact during production
I7	I buy locally (nationally) produced clothing
I8	I choose garments with labels that demonstrate the ethical behavior of the manufacturer
I9	I avoid buying garments made in countries where working conditions are close to exploitation
I10	I buy clothes without packaging
I11	I buy clothes with sustainable packaging
I12	I buy clothes made of reused materials
I13	When I am tired of my old clothes, I adapt them to create new ones
I14	I happen to rent clothes instead of buying them
I15	I happen to exchange my clothes with other people
I16	I buy second-hand modern clothing
I17	I buy original vintage clothing
I18	I try to reduce the number of washes of garments
I19	I wash clothing at low temperatures
I20	I wash clothes with a mild and/or natural detergent
I21	I pay attention to the directions on garment labels that state how to wash them
I22	I avoid using the dryer and/or ironing clothing whenever possible
I23	I repair/ mend my clothing items.
I24	I ask my family members and/or friends to help me repair my clothing items
I25	I go to a seamstress or the store where I bought the garments
I26	I donate my used clothing items to thrift stores or charity
I27	I sell my used clothing items to thrift stores or exchange them for other clothes
I28	I plot my used clothing items to family members/relatives
I29	I reuse my clothing items for other purposes or turn them into something new
I30	I modify/customize or repair my clothing items

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TABLE 4 – Frequency of item responses (n=5,124)

ITEM	1	2	3	4	5	
I1	135	460	1613	1828	1088	5124
I2	552	1040	1875	1104	553	5124
I3	185	583	1791	1682	883	5124
I4	372	975	2093	1173	511	5124
I5	113	394	1434	1921	1262	5124
I6	250	758	2022	1448	646	5124
I7	151	667	1985	1615	706	5124
I8	420	886	1876	1293	649	5124
I9	281	722	1706	1442	973	5124
I10	172	445	1426	1829	1252	5124
I11	241	635	1804	1515	929	5124
I12	581	1018	2102	1005	418	5124
I13	1042	980	1610	1015	477	5124
I14	2840	770	788	486	240	5124
I15	1531	895	1373	917	408	5124
I16	1271	874	1511	1026	442	5124
I17	2064	1066	1165	570	259	5124
I18	272	585	1647	1575	1045	5124
I19	100	317	1314	1809	1584	5124
I20	217	477	1478	1685	1267	5124
I21	172	450	1258	1533	1711	5124
I22	237	508	1178	1361	1840	5124
I23	695	827	1534	1182	886	5124
I24	943	775	1568	1126	712	5124
I25	923	882	1566	1094	659	5124
I26	581	626	1512	1427	978	5124
I27	1595	898	1325	843	463	5124
I28	543	747	1801	1313	720	5124
I29	369	695	1857	1372	831	5124
I30	786	963	1710	1045	620	5124

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TABLE 5 – Dimensionality test: alternative models fit

Model	Log-likelihood	N. est. parameters	AIC	BIC	AIC diff.	BIC diff.
Three-dimensional	-168,809.5	177	337,973.0	339,130.9	-4,246.6	-4,063.4
Two-dimensional	-170,960.8	149	342,219.6	343,194.3	-9,365.6	-9,175.9
Unidimensional	-175,672.6	120	351,585.2	352,370.2	-	-

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TABLE 6 – Goodness of fit statistics

Model	M2	df	p	RMSEA	SRMSR	TLI	CFI
Three-dimensional	2136.929	288	0.000	0.035	0.032	0.978	0.983
Two-dimensional	5578.546	316	0.000	0.057	0.051	0.942	0.951
Unidimensional	5629.310	345	0.000	0.055	0.085	0.947	0.951

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TABLE 7 – Results of the MIRT-GRM model

		DISCRIMINATION (α_{jv})			THRESHOLDS (k_{jk})		
		$\widehat{\alpha}_{j^1}$	$\widehat{\alpha}_{j^2}$	$\widehat{\alpha}_{j^3}$	$\hat{k}_{j(0-1)}$	$\hat{k}_{j(1-2)}$	$\hat{k}_{j(2-3)}$
I1	I choose the highest quality clothes available and durable over time	-0.096	0.426	**1.305**	2.612	0.373	-1.774
I2	I buy garments made with little use of water	0.266	-0.385	**2.469**	1.452	-1.284	-3.741
I3	I prefer buying clothes made from fibers produced through low environmental impact methods	-0.112	0.297	**2.370**	2.941	0.033	-2.747
I4	I buy clothes made from recycled materials	0.646	-0.34	**2.059**	1.809	-1.211	-3.775
I5	I prefer buying clothes made from natural fibers	-0.373	0.676	**1.319**	2.901	0.685	-1.551
I6	I choose garments that have a low environmental impact during production	0.025	-0.11	**2.853**	2.684	-0.665	-3.735
I7	I buy locally (nationally) produced clothing	0.013	0.172	**1.616**	2.326	-0.236	-2.608
I8	I choose garments with labels that demonstrate the ethical behavior of the manufacturer	0.219	-0.165	**2.472**	1.939	-0.868	-3.478
I9	I avoid buying garments made in countries where working conditions are close to exploitation	-0.134	0.259	**2.019**	2.211	-0.137	-2.296
I10	I buy clothes without packaging	0.029	0.603	**0.748**	2.357	0.504	-1.393
I11	I buy clothes with sustainable packaging	0.019	0.316	**1.741**	2.333	-0.112	-2.276
I12	I buy clothes made of reused materials	1.160	-0.137	**1.458**	1.378	-1.573	-4.012
I13	When I am tired of my old clothes I adapt them to create new ones	**1.504**	0.209	0.577	0.682	-1.365	-3.434
I14	I happen to rent clothes instead of buying them	**2.866**	-1.221	0.501	-2.076	-3.926	-6.081
I15	I happen to exchange my clothes with other people	**1.958**	0.055	0.123	0.166	-1.695	-3.786
I16	I buy second-hand modern clothing	**1.627**	-0.081	0.118	0.457	-1.362	-3.328
I17	I buy original vintage clothing	**2.037**	-0.614	0.288	-0.811	-2.749	-4.649
I18	I try to reduce the number of washes of garments	0.401	**1.195**	0.300	2.150	0.121	-1.815
I19	I wash clothing at low temperatures	-0.022	**1.648**	0.255	3.409	1.022	-1.206
I20	I wash clothes with a mild and/or natural detergent	0.144	**1.271**	0.866	2.700	0.517	-1.661

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I21	I pay attention to the directions on garment labels that state how to wash them	-0.241	**1.395**	0.684	2.813	0.850	-1.003
I22	I avoid using the dryer and/or ironing clothing whenever possible	0.081	**1.467**	0.051	2.414	0.759	-0.788
I23	I repair/ mend my clothing items.	**1.191**	0.774	-0.098	1.166	-0.489	-2.055
I24	I ask my family members and/or friends to help me repair my clothing items	**1.097**	0.459	0.007	0.880	-0.715	-2.275
I25	I go to a seamstress or the store where I bought the garments	**0.707**	0.258	0.458	0.763	-0.780	-2.317
I26	I donate my used clothing items to thrift stores or charity	**0.677**	0.538	0.339	1.431	-0.150	-1.770
I27	I sell my used clothing items to thrift stores or exchange them for other clothes	**1.748**	-0.073	-0.027	0.071	-1.590	-3.286
I28	I plot my used clothing items to family members/relatives	**1.435**	0.572	-0.009	1.522	-0.563	-2.497
I29	I reuse my clothing items for other purposes or turn them into something new	**0.970**	0.874	0.109	1.772	-0.334	-2.159
I30	I modify/customize or repair my clothing items	**1.989**	0.763	-0.097	1.103	-1.157	-3.154

v=1 for the *j* items on θ_1, v=2 for the *j* items on θ_2 and v=3 for the *j* items on θ_3

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TABLE 8 - Correlation matrix.

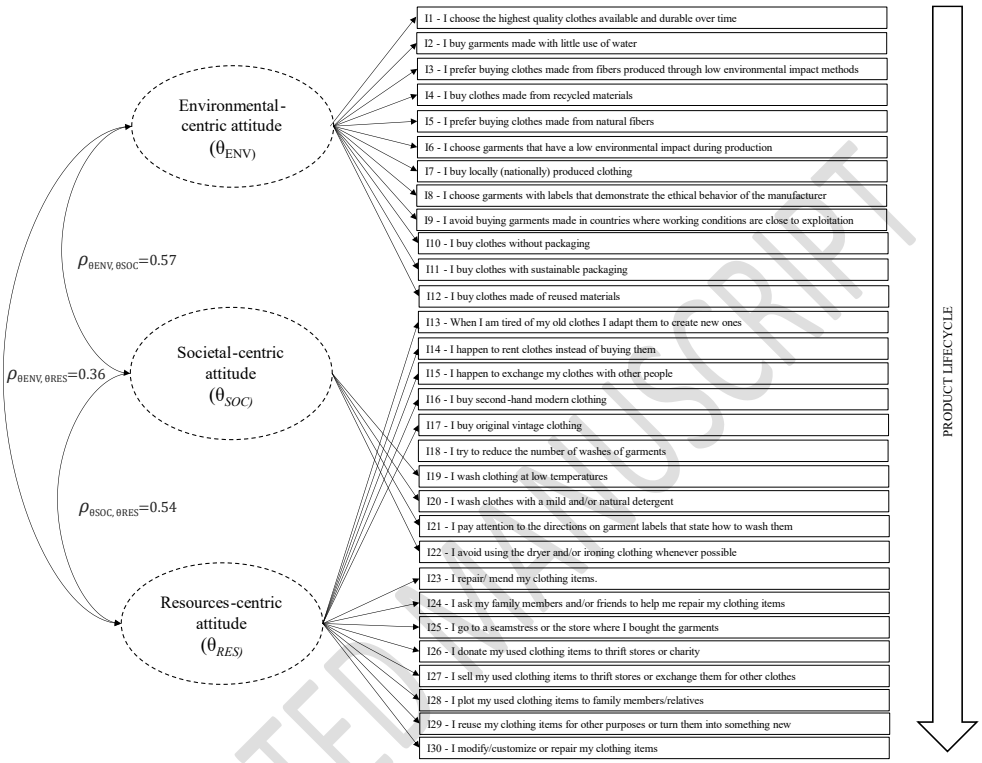
	θ_{SOC}	θ_{RES}	θ_{ENV}
θ_{SOC}	1		
θ_{RES}	0.054	1	
θ_{ENV}	0.574	0.357	1

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Figures

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FIGURE 1 – Results of the MIRT Model. Structure of the latent variables and their relationship (ex-post Pearson correlation coefficients)



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A Appendix

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TABLE A1: Mean item scores by country

	DE		ES		FR		IT		PL	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
I1	3.3	1.0	3.9	0.9	3.6	1.0	3.7	0.9	3.7	0.9
I2	2.9	1.1	3.1	1.1	2.8	1.2	3.1	1.2	3.2	1.1
I3	3.3	1.1	3.6	1.0	3.4	1.1	3.5	1.0	3.6	1.0
I4	2.9	1.0	3.2	1.0	3.0	1.0	3.1	1.1	3.3	1.0
I5	3.6	1.1	3.8	0.9	3.6	1.0	3.9	0.9	3.9	1.0
I6	3.2	1.0	3.4	1.0	3.1	1.0	3.4	1.0	3.4	1.0
I7	3.2	1.0	3.5	0.9	3.2	1.1	3.6	0.9	3.5	0.9
I8	3.0	1.1	3.3	1.1	3.0	1.1	3.4	1.1	3.2	1.1
I9	3.3	1.1	3.5	1.1	3.4	1.1	3.5	1.1	3.4	1.1
I10	3.8	1.1	3.7	1.0	3.6	1.0	3.7	1.0	3.7	1.0
I11	3.4	1.1	3.5	1.1	3.4	1.1	3.5	1.0	3.5	1.1
I12	2.8	1.1	3.0	1.1	2.8	1.1	2.9	1.1	3.1	1.1
I13	2.3	1.2	3.1	1.2	2.6	1.3	2.9	1.2	3.1	1.1
I14	1.7	1.1	2.0	1.2	1.9	1.2	1.9	1.3	2.2	1.3
I15	2.2	1.3	2.7	1.3	2.5	1.3	2.6	1.3	2.8	1.2
I16	2.6	1.3	2.6	1.3	2.7	1.3	2.5	1.3	3.2	1.2
I17	2.0	1.1	2.2	1.2	2.2	1.2	2.2	1.3	2.4	1.2
I18	3.4	1.1	3.7	1.1	3.3	1.2	3.6	1.0	3.5	1.1
I19	3.8	1.0	3.9	1.0	3.9	1.0	3.9	0.9	3.8	0.9
I20	3.5	1.1	3.8	1.0	3.4	1.2	3.8	1.0	3.7	1.0
I21	3.7	1.2	3.8	1.1	3.8	1.2	3.9	1.0	3.8	1.1
I22	3.8	1.2	3.8	1.1	3.8	1.2	3.8	1.1	3.7	1.1
I23	2.9	1.3	3.3	1.2	3.2	1.3	3.1	1.3	3.2	1.2
I24	2.6	1.3	3.2	1.2	2.9	1.3	3.2	1.3	3.0	1.2
I25	2.7	1.2	3.3	1.2	2.6	1.3	3.1	1.2	3.0	1.2
I26	3.2	1.2	3.4	1.2	3.3	1.3	3.5	1.2	3.2	1.2
I27	2.4	1.3	2.6	1.3	2.5	1.4	2.6	1.3	2.6	1.3
I28	2.9	1.2	3.4	1.1	3.1	1.2	3.2	1.2	3.4	1.1
I29	3.0	1.1	3.4	1.1	3.3	1.2	3.4	1.1	3.5	1.0
I30	2.8	1.2	3.1	1.2	2.7	1.3	3.0	1.2	3.1	1.1
Cronb.α	0.92		0.92		0.93		0.92		0.94	

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TABLE A2a: Group validity tests (OLS regression models by country)

Dep. Variable: θ_1	DE	ES	IT	FR	PL
Age group					
(base =18-24 years)					
25-34 years	-0.042*	0.011	0.009	-0.030	0.015
35-44 years	-0.086***	-0.007	-0.027	-0.103***	0.002
45-54 years	-0.103***	-0.044*	- 0.062***	-0.135***	-0.003
55-70 years	-0.110***	-0.049**	-0.088***	-0.163***	-0.026
Gender:					
(base=male)					
Female	0.030***	0.035***	0.022**	0.001	0.055***
Town_size:					
(base = <10.000 res.)					
10.000-30.000 res.	-0.001	-0.025	0.032*	-0.016	-0.010
30.000-100.000 res.	0.015	-0.001	0.044***	0.010	-0.019
100.000-250.000 res.	0.006	0.011	0.013	0.046**	-0.035*
250.000-500.000 res.	0.031	-0.019	0.067***	-0.006	0.003
> 500.000 res.	0.011	0.008	0.033*	0.050**	0.002
N. family_members:					
(base = 1 person)					
2 persons	0.004	0.025	-0.040*	-0.004	-0.015
3 persons	0.020	0.058	0.002	-0.015	-0.019
4 persons	0.031	0.065	0.024	0.020	0.005
5+ persons	0.050**	0.048	0.070***	-0.002	0.023
Income_class:					
(base = very low)					
low	-0.020	-0.011	0.071*	0.007	-0.110**
medium-low	-0.074**	-0.048	0.020	-0.005	-0.085
medium	-0.055*	-0.051	0.047	-0.012	-0.081
medium-high	-0.021	0.020	0.050	0.010	-0.065
high	0.014	-0.011	0.110	-0.046	-0.036
very high	0.121***	0.057	0.113	0.164	0.125**
N/A	-0.061	-0.008	0.001	-0.021	-0.101
Education:					
(base= Elementary school diploma)					
Lower s.s. diploma	-0.017	0.007	0.037	0.017	0.003
Upper s.s. (no diploma)	0.050	-0.022	0.111	0.014	0.034
Upper s.s. diploma	-0.018	-0.012	0.031	-0.011	0.017
University (no degree)	0.027	-0.023	0.037	0.005	0 .000
Bachelor's degree +	-0.008	-0.037	0.003	-0.034	-0.011
Job (dummies)	YES	YES	YES	YES	YES
Civil state (dummies)	YES	YES	YES	YES	YES
Constant	0.490***	0.478***	0.350***	0.530***	0.522***
N	1,018	1,016	1,053	1,012	1,025
R-squared	0.216	0.149	0.159	0.177	0.124
F-test	6.086***	3.860***	4.339***	4.727***	3.156***

*** *p<.01, ** p<.05, * p<.1*

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TABLE A2b: Group validity tests (OLS regression models by country)

Dep. Variable: θ_2	DE	ES	IT	FR	PL
Age group					
(base =18-24 years)					
25-34 years	**0.033***	**0.046****	**0.020**	-0.008	**0.011**
35-44 years	**0.053*****	**0.077*****	**0.011**	0.007	**0.040***
45-54 years	**0.095*****	**0.113*****	**0.072*****	0.016	**0.042***
55-70 years	**0.147*****	**0.154*****	**0.083*****	0.078***	**0.088*****
Gender:					
(base=male)					
Female	**0.042*****	**0.054*****	**0.049*****	0.040***	**0.057*****
Town_size:					
(base = <10.000 ab.)					
10.000-30.000 res.	0.010	0.006	-0.006	-0.029**	0.018
30.000-100.000 res.	0.019	0.007	0.008	-0.001	0.005
100.000-250.000 res.	0.029*	0.011	0.007	0.011	0.029*
250.000-500.000 res.	0.026	0.000	0.014	-0.013	0.022
> 500.000 res.	0.016	0.012	0.015	0.021	0.041**
N. family_members:					
(base = 1 person)					
2 persons	-0.010	-0.016	0.002	-0.037**	-0.023
3 persons	-0.022	-0.016	-0.001	-0.045**	-0.026
4 persons	0.006	0.000	0.005	-0.030	-0.020
5+ persons	0.020	-0.040	0.032	-0.025	0.002
Income_class:					
(base = very low)					
low	-0.014	-0.077*	0.036	-0.009	-0.058
medium-low	-0.015	-0.079**	0.030	-0.013	0.022
medium	-0.014	-0.066*	0.051*	-0.008	0.009
medium-high	-0.003	-0.062	0.045	-0.014	-0.003
high	-0.023	-0.037	0.034	-0.021	-0.025
very high	-0.009	-0.034	0.021	0.087*	0.074
N/A	-0.088**	-0.163**	-0.003	-0.038	-0.055
Education:					
(base= Elementary school diploma)					
Lower s.s. diploma	0.086*	0.021	0.071	0.026	-0.023
Upper s.s. (no diploma)	0.103**	0.008	0.069	0.007	-0.026
Upper s.s. diploma	0.152***	0.066	0.085	0.043*	-0.020
University (no degree)	0.113**	0.041	0.098	0.056**	0.002
Bachelor's degree +	0.136***	0.074**	0.100	0.073***	-0.023
Job (dummies)	YES	YES	YES	YES	YES
Civil state (dummies)	YES	YES	YES	YES	YES
Constant	0.263***	0.474***	0.358***	0.382***	0.422***
N	1,018	1,016	1,053	1,012	1,025
R-squared	0.186	0.152	0.132	0.133	0.201
F-test	5.053***	3.966***	3.489***	3.360***	5.069***

*** *p<.01, ** p<.05, * p<.1*

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TABLE A2c: Group validity tests (OLS regression models by country)

Dep. Variable: θ_3	DE	ES	IT	FR	PL
Age group					
(base =18-24 years)					
25-34 years	0.012	0.022	0.035	-0.026	0.025
35-44 years	-0.006	0.038	0.005	-0.074***	0.028
45-54 years	0.017	0.038	0.012	-0.077***	0.038
55-70 years	0.042*	0.077***	0.016	-0.069***	0.044
Gender:					
(base=male)					
Female	**0.027****	**0.025****	**0.019***	**0.000**	**0.051*****
Town_size:					
(base = <10.000 ab.)					
10.000-30.000 res.	-0.004	-0.002	0.020	-0.012	0.001
30.000-100.000 res.	0.016	0.036	0.027*	0.019	-0.013
100.000-250.000 res.	0.001	0.024	0.014	0.030	-0.004
250.000-500.000 res.	0.032	-0.010	0.053**	-0.011	0.012
> 500.000 res.	0.017	0.027	0.021	0.069***	0.030
N. family_members:					
(base = 1 person)					
2 persons	0.011	0.012	-0.029	-0.020	-0.037*
3 persons	0.015	0.033	0.004	-0.037*	-0.033
4 persons	0.032	0.043	0.013	-0.013	-0.022
5+ persons	0.074***	0.017	0.045*	-0.010	-0.006
Income_class:					
(base = very low)					
low	-0.015	-0.030	0.072*	0.029	-0.058
medium-low	-0.048	-0.046	0.047	0.017	-0.028
medium	-0.013	-0.036	0.084**	0.023	-0.015
medium-high	0.016	0.019	0.092***	0.043	-0.006
high	0.022	0.003	0.132**	0.011	0.019
very high	0.082*	0.050	0.087	0.198***	0.162***
N/A	-0.015	-0.028	0.035	-0.040	-0.083
Education:					
(base= Elementary school diploma)					
Lower s.s. diploma	-0.036	-0.011	0.129	0.028	-0.010
Upper s.s. (no diploma)	0.000	-0.033	0.162	-0.008	0.039
Upper s.s. diploma	-0.016	0.011	0.140	-0.009	0.028
University (no degree)	0.001	-0.015	0.152	-0.004	0.006
Bachelor's degree +	-0.024	-0.006	0.134	-0.016	0.000
Job (dummies)	YES	YES	YES	YES	YES
Civil state (dummies)	YES	YES	YES	YES	YES
Constant	0.418***	0.438***	0.205***	0.471***	0.431***
N	1,018	1,016	1,053	1,012	1,025
R-squared	0.086	0.097	0.078	0.089	0.110
F-test	2.090***	2.358***	1.951***	2.140***	2.763***

*** *p<.01, ** p<.05, * p<.1*

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B Appendix - Reliability analysis

As a first step, we performed known groups validity tests by comparing groups of consumers in each country for each of the latent characteristics of interest.

In each sub-sample (i.e. across countries) groups of consumers are compared based on the individual-level continuous measures of the three latent characteristics estimated through the MIRT-GRM model (θ_1; θ_2; θ_3). The known groups are defined using the following socio-demographic characteristics: age group, gender, number of family members, education, income class, job, civil state, and town size). We use a linear regression model to evaluate and test the statistical significance of the estimated coefficients in different groups (Tables A2a-A2c in the Appendix). As expected, the three models show that female individuals score higher compared to male individuals on the three latent characteristics across subsamples of consumers in different countries.

A positive and significant difference in the average value of θ_1 for female consumers (compared to male consumers) is observed in Germany (β_F=0.030, p<0.01), Spain (β_F=0.035, p<0.01), Italy (β_F=0.022, p<0.1) and Poland (β_F=0.055, p<0.00) except for France, where the coefficient, near to zero, does not reach statistical significance (Table A2a). Similar differences are observed on the average value of θ_2, with female consumers scoring higher in Germany (β_F=0.042, p<0.001), Spain (β_F=0.054, p<0.001), Italy (β_F=0.049, p<0.001) France (β_F=0.040, p<0.001) and Poland (β_F=0.057, p<0.001) (Table A2b). Finally, significantly higher scores on θ_3 are observed for female consumers in Germany (β_F=0.027, p<0.01), Spain (β_F=0.025, p<0.01), Italy (β_F=0.019, p<0.01 and Poland (β_F=0.051, p<0.001) with the exception of France where the coefficient, near to zero, does not reach statistical significance (Table A2c). Another interesting result is related to the age groups' comparison of the three latent characteristics. Considering the average value of θ_1 the coefficients consistently decrease (assuming negative values) across groups of increasing age in all countries (except for Poland) compared to the baseline group (18-24 years). On the opposite considering the average value of θ_2, the coefficients consistently increase across groups of increasing age in all countries. This relationship is not verified on θ_3 across countries.

Adding to the dimensionality and discriminant validity tests (see Table 4 and Table 5), we performed further tests of external validity, to establish whether the latent constructs could be conceptualized in the same way across countries. Evidence of invariance on the meaning and the structure of the latent constructs across countries is useful to establish whether the approach (and the proposed scales for different latent constructs)

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is can be used in multinational research.

We tested the MIRT-GRM model separately in each country using an exploratory approach (Byrne, 2010).

Table B1 gives the goodness of fit indices for each nation.

TABLE B1 – Three-dimensional MIRT-GRM model by nation

Nation	N	M2	df	p	RMSEA	SRMSR	TLI	CFI
DE	1,018	791.84	288	0.000	0.041	0.035	0.967	0.975
ES	1,016	592.39	288	0.000	0.032	0.036	0.979	0.984
FR	1,053	586.69	288	0.000	0.032	0.036	0.984	0.988
IT	1,012	680.38	288	0.000	0.036	0.036	0.975	0.981
PL	1,025	821.40	288	0.000	0.043	0.036	0.971	0.978

The goodness of fit statistics on the different samples demonstrate that all indices fall within the boundaries outlined above (Maydeu-Olivares and Joe, 2014). Specifically, for all countries the values of RMSEA fall below the threshold of close fit (RMSEA<0.05), and the values of SRMSR are indicative adequate fit (SRMSR<0.05). Therefore, the model fit is acceptable for all the nations, providing evidence of invariance of the structure of the latent construct.

Further evidence of invariance on the meaning of the latent construct is reported in Table B2, reporting the estimations of MIRT-GRM parameters for the different sub-samples.

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TABLE B2- Item-level estimates of the MIRT-GRM models by nation.
Discrimination parameters (α_{jv})

	DE			ES			FR			IT			PL		
	$\hat{\alpha}_{j1}$	$\hat{\alpha}_{j2}$	$\hat{\alpha}_{j3}$	$\hat{\alpha}_{j1}$	$\hat{\alpha}_{j2}$	$\hat{\alpha}_{j3}$	$\hat{\alpha}_{j1}$	$\hat{\alpha}_{j2}$	$\hat{\alpha}_{j3}$	$\hat{\alpha}_{j1}$	$\hat{\alpha}_{j2}$	$\hat{\alpha}_{j3}$	$\hat{\alpha}_{j1}$	$\hat{\alpha}_{j2}$	$\hat{\alpha}_{j3}$
I1	0.014	0.056	**1.222**	-0.320	0.622	**1.290**	-0.270	0.335	**1.783**	0.032	0.571	**0.959**	-0.331	0.540	**1.409**
I2	0.095	-0.372	**2.623**	0.395	-0.342	**2.118**	0.428	-0.475	**2.398**	0.271	-0.351	**2.218**	0.319	-0.278	**2.878**
I3	0.071	0.437	**2.079**	-0.253	0.452	**2.167**	-0.276	0.218	**2.663**	0.043	0.198	**2.364**	-0.094	0.270	**2.536**
I4	0.446	-0.336	**1.839**	0.542	-0.502	**2.100**	0.778	-0.049	**2.043**	0.782	-0.308	**1.978**	0.759	-0.273	**2.290**
I5	-0.212	0.663	**1.217**	-0.449	0.515	**1.419**	-0.469	0.585	**1.501**	-0.313	1.074	**0.848**	-0.444	0.661	**1.318**
I6	-0.098	0.089	**2.742**	0.214	-0.085	**2.422**	0.306	-0.184	**2.834**	-0.077	-0.154	**2.895**	0.110	-0.015	**3.122**
I7	0.009	-0.015	**1.640**	0.035	0.210	**1.496**	0.021	-0.152	**2.152**	-0.075	0.421	**1.295**	-0.049	0.295	**1.475**
I8	0.067	-0.382	**2.630**	0.317	-0.249	**2.262**	0.517	-0.163	**2.527**	0.088	0.143	**2.052**	0.368	-0.101	**2.650**
I9	-0.090	0.302	**2.111**	-0.122	0.097	**1.933**	-0.081	0.322	**2.002**	-0.139	0.417	**1.898**	-0.045	0.252	**2.026**
I10	-0.159	0.930	**0.966**	0.206	0.537	**0.694**	0.026	0.718	**0.781**	0.172	0.594	**0.612**	0.128	0.582	**0.639**
I11	-0.044	0.431	**1.837**	0.062	0.232	**1.818**	-0.053	0.347	**1.844**	0.048	0.412	**1.582**	0.258	0.258	**1.585**
I12	0.793	-0.027	**1.387**	1.110	-0.218	**1.555**	1.347	-0.040	**1.386**	1.384	-0.057	**1.374**	1.299	-0.093	**1.559**
I13	**1.531**	-0.300	0.737	**1.389**	0.354	0.517	**1.538**	0.206	0.495	**1.489**	0.426	0.394	**1.196**	0.300	0.885
I14	**3.259**	-2.254	0.614	**2.563**	-1.155	0.444	**3.102**	-1.143	0.492	**3.053**	-0.964	0.539	**2.456**	-0.776	0.674
I15	**2.090**	-0.085	0.095	**1.767**	0.174	0.191	**1.934**	0.167	0.096	**1.952**	0.213	-0.056	**1.809**	-0.049	0.432
I16	**1.598**	0.133	0.068	**2.022**	-0.264	0.372	**1.584**	0.190	0.036	**2.202**	-0.289	0.198	**1.265**	0.082	0.120
I17	**1.865**	-0.906	0.203	**1.738**	-0.723	0.448	**2.570**	-0.429	0.031	**2.538**	-0.521	0.241	**1.475**	-0.301	0.538
I18	0.467	**0.917**	0.522	0.336	**1.415**	0.125	0.445	**0.987**	0.354	0.257	**1.293**	0.163	0.368	**1.388**	0.188

I19	0.138	**1.723**	0.252	-0.228	**1.439**	0.523	-0.053	**1.714**	0.202	-0.038	**1.753**	0.067	0.047	**1.729**	0.175
I20	0.369	**1.033**	0.912	0.150	**1.179**	0.738	0.149	**1.225**	0.849	-0.029	**1.354**	0.748	-0.130	**1.609**	0.904
I21	0.031	**1.210**	0.594	-0.432	**1.096**	0.818	-0.268	**1.405**	0.598	-0.403	**1.661**	0.533	-0.248	**1.849**	0.681
I22	0.087	**1.236**	0.169	0.206	**1.620**	0.046	0.000	**1.466**	0.023	0.086	**1.551**	-0.103	-0.027	**1.630**	0.070
I23	**1.331**	0.564	-0.082	**1.230**	0.856	-0.039	0.944	**1.050**	0.010	**0.998**	0.541	0.025	**1.117**	0.903	-0.197
I24	**1.015**	0.134	0.135	**1.054**	0.612	0.064	**1.101**	0.533	0.014	**1.067**	0.746	-0.229	**1.195**	0.265	-0.009
I25	**0.783**	0.083	0.423	**0.333**	0.345	0.571	**1.187**	0.160	0.386	**0.484**	0.377	0.492	**0.823**	0.237	0.302
I26	**0.842**	0.527	0.206	**0.432**	0.377	0.564	**0.748**	0.726	0.277	**0.587**	0.586	0.311	**0.842**	0.560	0.256
I27	**1.751**	0.018	0.032	**1.891**	-0.076	-0.172	**1.711**	0.084	-0.035	**1.905**	-0.150	0.031	**1.700**	-0.104	0.130
I28	**1.523**	0.353	-0.070	**1.367**	0.742	0.091	**1.196**	0.510	0.106	**1.488**	0.519	-0.184	**1.179**	0.868	0.135
I29	**1.050**	0.663	-0.043	**0.978**	0.816	0.233	0.836	**0.967**	0.135	0.728	**0.878**	0.119	**1.025**	1.258	-0.124
I30	**1.921**	0.613	-0.057	**2.023**	0.846	0.014	**1.906**	0.912	0.006	**1.819**	0.612	-0.064	**1.789**	1.005	-0.065

v=1 for the *j* items on θ_1, v=2 for the *j* items on θ_2 and v=3 for the *j* items on θ_3

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