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# Is circular economy inclusive? Assessing the engagement of vulnerable households in circular consumption behaviours

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ABSTRACT

The transition to a sustainable circular economy requires the widespread adoption of circular consumption behaviours, yet little is known about how these behaviours are distributed across society, and whether this distribution is equitable. The contribution of individuals through behaviours such as repairing, renting and maintaining is crucial but often overlooked, overshadowed by contributions by industrial sectors. In particular, the role of vulnerable households, affected by economic, social, and structural disadvantages, has not been systematically examined, even though both the constraints and opportunities posed by the circular economy may be amplified for them. This study investigates how individuals contribute to the circular economy transition through their engagement in circular consumption behaviours and examines the extent of inequalities in such engagement comparing vulnerable and non-vulnerable households. Using data from the 2022 Household Budget Survey in Italy and Portugal and applying a regression approach combined with a propensity score matching model integrated by household vulnerability archetypes, this study analyses patterns of engagement in circular consumption behaviours across socioeconomic groups. Results show that households characterized by higher income, better education, younger age, and male household heads are more likely to engage in circular consumption behaviours, while vulnerability constitutes a substantial barrier to engagement in the circular economy suggesting that the circular economy may extend existing advantages and perpetuate socioeconomic inequalities. These findings extend previous research on the contribution of individuals to the circular economy by integrating a social equity perspective and highlight the need for policies that ensure equitable access to circular economy opportunities.

## 1. Introduction

By promoting the (i) narrowing, (ii) extending, and (iii) closing of resource loops, as well as (iv) the regeneration of ecosystems, the Circular Economy (CE) model fosters the reuse, refurbishment, and recycling of materials, thereby reducing dependence on virgin resources and minimizing environmental impacts and waste generation (Ottelin et al., 2020). Recently, it has been recognized as a transformative framework aligned with a broader vision of sustainable development (Schroeder et al., 2019). In particular, the concept of a Sustainable Circular Economy (SCE) (Blum et al., 2020), (Velenturf and Purnell, 2021a) highlights the importance of embedding CE within the broader sustainability agenda by considering long-term system viability, resilience, and the interdependence of material, environmental, economic, and social outcomes. This integrated approach aims to advance in parallel material reuse, environmental protection, economic prosperity and social equity (Figge et al., 2023), (Kirchherr et al., 2017). In fact, while CE strategies and approaches frequently emphasize material circularity, these actions alone do not guarantee broader sustainability outcomes, because of the multidimensionality of the sustainability concept. SCE, as a systemic transition towards sustainability, holds the potential to make substantial contributions to several Sustainable Development Goals, including those related to responsible consumption and production, climate action, poverty reduction and employment (Schroeder et al., 2019), (Clube and

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Tennant, 2022).

Most of the CE literature emphasizes tensions between its material, environmental and economic dimensions, including its business models (Dagilienė and Varaniūtė, 2023), while paying comparatively less attention to its social implications (Liu, 2025), (Murray et al., 2017), (Corvellec et al., 2022). Job creation is the most frequently cited positive social outcome of CE transitions (Clube and Tennant, 2022), particularly in sectors related to waste management. However, waste-related activities are not universally beneficial. In some cases, vulnerable communities have been displaced into areas disproportionately burdened by waste infrastructure, contributing to deteriorating living conditions and reinforcing existing inequalities (Valenzuela and Böhm, 2017). These dynamics highlight the need for integrated analytical frameworks that explicitly link circularity strategies with considerations of social equity. Advancing such frameworks is essential for developing a more comprehensive understanding of the social consequences of CE practices and for ensuring that CE transitions are both sustainable and just (McCauley, 2025), (Velenturf and Purnell, 2021b).

In this respect, societal engagement with the CE is critical, particularly the roles played by individuals, households, communities, and informal sectors, yet these dimensions remain relatively underexplored (Da Silva and Ramos, 2024). Households represent not only end-users of products but also potential agents of change who can advance CE principles through circular consumption behaviours, while simultaneously being major consumers of resources and producers of waste. Circular consumption behaviours, including repairing, reusing, upcycling, recycling, ensuring proper disposal, and reducing overall consumption, can substantially reduce the environmental impacts of consumption while contributing to reshape supply chains toward more sustainable consumption patterns (Wethal and Hoff, 2024). For example, households that choose second-hand goods or make use of repair services can contribute to reducing the demand for virgin materials and lowering waste generation at the source.

Despite this potential, most CE research and policy initiatives have focused on industrial processes, technological innovation, and large-scale systems change, while comparatively limited attention has been paid to contributions at the household level (Wethal and Hoff, 2024). This gap highlights the need for a more systematic examination of how circular consumption behaviours diffuse across different social groups, and of the implications this may hold for social equity, particularly in terms of fair and inclusive access to CE opportunities.

Recognizing the importance of household-level action in the CE, policymakers are increasingly developing initiatives aimed at encouraging circular consumption behaviours. These include educational campaigns, financial incentives to support repair and reuse, and the promotion of sharing economies that discourage individual asset ownership and increase product utilization rates (Zibell et al., 2025), (Jiménez Encarnación et al., 2024). However, such efforts often overlook the diversity of household conditions, particularly the specific barriers faced by vulnerable households (McCauley, 2025). Vulnerable households affected by economic, social, or structural disadvantages encounter a complex interplay of constraints and opportunities in engaging in circular consumption behaviours. For example, limited financial resources may restrict access to durable or sustainably designed products, while digital divides can impede participation in sharing economy platforms (Sovacool et al., 2021a). At the same time, economic necessity may encourage these households to repair, repurpose, or reuse goods. Such dynamics can lead to unequal access to circular products and behaviours, especially among households experiencing socioeconomic vulnerabilities. Developing a nuanced understanding of how these vulnerabilities shape circular consumption is therefore essential for designing policies that reduce inequalities in access to circular products and services and support a more inclusive CE transition.

Fig. 1 illustrates the main focus of current CE research and policy focus, as well as the key gaps that this study aims to address. As previously mentioned, most CE research and policy interventions focus on industry, particularly on industrial sectors and production processes. This emphasis aligns with the predominant attention given to improving sustainability performance through the circular economy model, mainly with regard to three out of four SCE dimensions, the material, economic, and environmental dimensions and their intersections. By contrast, comparatively less attention has been devoted to individuals as potential agents of change and to the social dimension of SCE. Advancing knowledge on these aspects and encouraging policymakers to consider the role of individuals in circular consumption behaviours can help expand the transformative potential of the CE model by more explicitly integrating social equity considerations into its outcomes.

Based on these premises, the aim of this study is to examine the extent to which vulnerable households engage in circular consumption behaviours, and whether differences emerge between vulnerable and non-vulnerable households, as illustrated in Fig. 2. To this end, the study addresses the following research questions:

1. Which socioeconomic factors predict circular consumption behaviours?
2. How can household vulnerability be defined in this context?
3. To what extent do vulnerable households engage in circular consumption behaviours, and how does their engagement compare with that of non-vulnerable households?

By addressing these questions, this study contributes to the SCE literature by clarifying and operationalizing the concepts of circular consumption behaviours and household vulnerability. In doing so, it advances understanding of the roles of individuals and households in SCE transitions and provides insights into the social equity implications of circular consumption, particularly with regard to unequal access to circular opportunities.

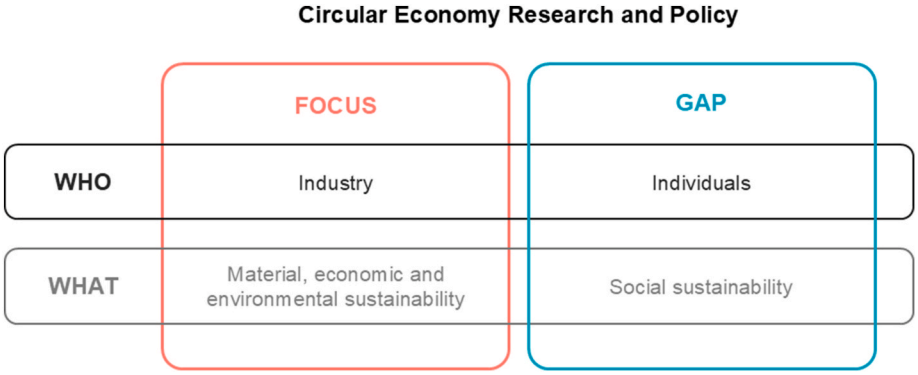


**Fig. 1.** Current focus of CE research strands and policy and related gaps that this study aims to address with its research questions and design.

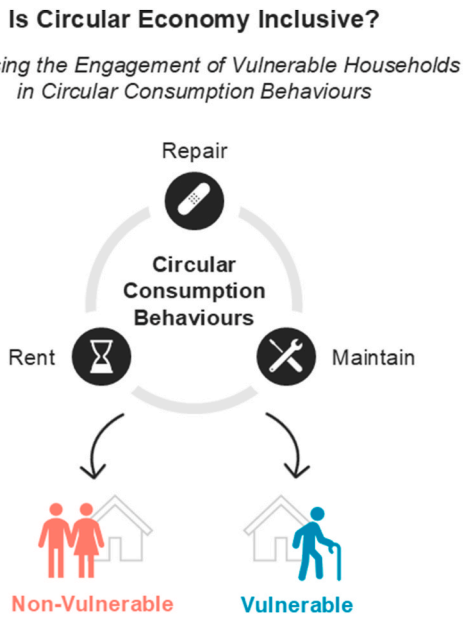


**Fig. 2.** Graphic summary of the study.

The analysis is based on case studies of Italy and Portugal, two Southern European countries with broadly similar socioeconomic contexts but distinct regulatory and policy frameworks shaping consumer behaviour and the implementation of circular economy measures.

This paper is structured as follows. Section 2 reviews the literature on the contribution of individuals to the CE, the factors influencing such contribution (section 2.1), and the role of vulnerability (section 2.2). Section 3 presents the data and methods. Section 4 reports the results. Section 5 discusses the findings and concludes with policy recommendations for fostering an inclusive and fair CE and offers directions for future research on equity in CE.

## 2. Theoretical background

### 2.1. Household consumption behaviour and circular economy

Household consumption is a major component of the economy and a key driver of gross domestic product. Higher consumption traditionally stimulates demand for goods and services, encouraging firms to expand production and investment, thereby fostering economic growth (Spencer, 2025). However, this growth-oriented model has proven environmentally unsustainable and socially detrimental, as continued expansion risks exacerbating environmental degradation and undermining human well-being (Spencer, 2025). The CE approach seeks to address these challenges by replacing the linear 'end-of-life' model with strategies for reducing, reusing, recycling, and recovering materials across production, distribution, and consumption processes (Da Silva and Ramos, 2024). These strategies aim to narrow (i.e. use fewer materials and energy), slow (i.e. use longer), close (i.e. recycle products) and substitute (i.e. replace products with lower-impact or renewable alternatives) resource flows (Konietzko et al., 2020), (Koch et al., 2024). The 10R framework (Potting et al, 2017) further broadens the scope of CE by supporting a shift in consumption patterns from "consume more" to "consume differently, or less" (Parajuly et al., 2020).

Within the CE literature, consumption is conceptualized in multiple forms, including sustainable (Bjelle et al., 2021), (Camacho-Otero et al., 2018), responsible (Falcão and Roseira, 2022), circular (Da Silva and Ramos, 2024), (Koch et al., 2024), and collaborative (Böcker and Meelen, 2017) consumption. Circular consumption emphasizes behaviours (Da Silva and Ramos, 2024) that extend product lifespans or transform waste into resources, thereby promoting "R-behaviours" (Tan and Yeoh, 2025), while collaborative consumption focuses on peer-to-peer exchanges that underpin the sharing economy (Böcker and Meelen, 2017). Despite these distinctions, all definitions underscore behaviours intended to reduce negative impacts or generate positive environmental and societal outcomes. In this study, circular consumption behaviours are defined following Koch et al. (2024), as the actions through which households acquire, use, and dispose of goods and services in ways that support CE principles.

Consumption can be understood across three main phases in which households make choices that align with either linear or circular consumption behaviours: acquiring, using, and disposing of products (Da Silva and Ramos, 2024), (Koch et al., 2024). In the acquiring phase, households may contribute to R-strategies such as *Rethink* by questioning the necessity of a purchase and opting for reuse or service-based alternatives (borrowing, leasing, renting, sharing) instead of buying new products. They may also support *Recycle* by purchasing products made from recycled or recyclable materials. The R-strategy *Refuse* is relevant only at this stage, when households choose to forgo a product or select a digital alternative (Koch et al., 2024). In the use phase, maintaining, repairing, refurbishing, or upgrading items extends product lifespans and slows resource flows (Koch et al., 2024). In the disposal phase, households may slow resource flows through resale, donation, repair, or refurbishment, and close material loops by returning resources to production systems through recycling (Da Silva and Ramos, 2024), (Zibell et al., 2025), (Wastling et al., 2018).

Despite the recognized importance of households in realizing CE objectives (Jiménez Encarnación et al., 2024), (Parajuly et al., 2020), (Edbring et al., 2016), the uptake of circular consumption behaviours across these phases remains limited (Da Silva and Ramos, 2024). Successful adoption requires that such behaviours be perceived as feasible, acceptable, and beneficial (Shevchenko et al., 2023), (Borrello et al., 2020). These perceptions are shaped by multiple factors, including socioeconomic conditions, product prices, attitudes, and purchasing contexts (Jiménez Encarnación et al., 2024), (Shevchenko et al., 2023), (Knickmeyer, 2020), as well as product and service availability, knowledge levels, social norms, and psychological influences (Camacho-Otero et al., 2018). Broader determinants such as product type (Cerulli-Harms et al., 2018), stage in the product consumption life cycle (Ottelin et al., 2020), (Dagilienė and Varaniūtė, 2023), and wider political, legal, economic, environmental, demographic, and socio-cultural contexts (Velenturf and Purnell, 2021a) also play a decisive role in shaping household decisions.

This diversity of influencing factors and the heterogeneity of existing findings indicate that circular consumption is highly context-dependent (Da Silva and Ramos, 2024), shaped by both product-specific attributes and household socioeconomic characteristics (Jiménez Encarnación et al., 2024). For instance, circular consumption behaviours are generally more common in collectivist cultures (Borrello et al., 2020). Zimmerman et al. (Zimmermann et al., 2024) show that individuals born between 1980 and 2000 are more inclined to engage in circular consumption behaviours than earlier or later cohorts, and that higher education is positively associated with such engagement. Jiménez Encarnación et al. (Jiménez Encarnación et al., 2024) further found gender differences, observing that men were less likely than women to reduce consumption by participating in sharing, while individuals with higher education showed more positive attitudes toward sharing initiatives.

In the CE literature, a substantial body of research addresses circular consumption, yet most studies focus on the individual consumer, with household-level consumption receiving comparatively less attention. Within this literature, three main strands can be identified: (i) factors influencing circular consumption behaviours, including the intention–action gap (Da Silva and Ramos, 2024), (Sovacool et al., 2021a), (Tan and Yeoh, 2025), (Geissdoerfer et al., 2017), (Whetstone et al., 2020), (Salo et al., 2021); (ii) perception and acceptance of circular consumption (Camacho-Otero et al., 2018), (Zimmermann et al., 2024),

(Whetstone et al., 2020); and (iii) impacts of circular consumption behaviour (Wastling et al., 2018). Only a limited number of studies have examined circular consumption from a household-level perspective, linking behaviours with household archetypes (Whetstone et al., 2020) or carbon footprints (Ottelin et al., 2020), (Salo et al., 2021), while examining how these vary across socioeconomic and spatial factors using household budget survey (HBS) data. For instance, Jiménez Encarnación et al. (Jiménez Encarnación et al., 2024) explored socio-demographic characteristics and sharing activities in a case study of Gothenburg, Sweden, and Whetstone et al. (2020) developed household archetypes for the same urban context. Expanding empirical investigation beyond single urban case studies and comparing household circular consumption across diverse socioeconomic and spatial settings, offers potential to deepen understanding of household-level dynamics and to inform policies that support more inclusive and effective CE transitions.

### 2.2. Social implications of CE and (un)equal adoption of circular consumption behaviours

The social implications of the CE are diverse (McCauley, 2025), (Purvis et al., 2023). While some are well documented, others remain underexplored, as CE research continues to be dominated by technological and economic perspectives (Liu, 2025). Existing literature highlights potential social benefits linked to circular consumption behaviours and related lifestyle changes, including improved access to goods and services for people living in poverty, enhanced social inclusion through the empowerment of marginalized groups such as youth and immigrants, and better public health outcomes associated with reduced pollution (Liu, 2025), (Velenturf and Purnell, 2021a), (Marjamaa and Mäkelä, 2022).

However, possible negative consequences also require consideration. For example, many CE-related jobs are precarious or unpaid, ultimately failing to effectively reduce poverty and reflecting tensions between circular principles and prevailing economic systems (Liu, 2025). CE transitions risk exacerbate global and local inequalities, particularly between the Global North and South (Liu, 2025). Vulnerable groups are often at greater risk of experiencing adverse effects. As Sovacool et al. (2019) highlight, current low-carbon transitions, including the CE one risk generating new forms of vulnerability, while failing to address the structural roots of existing inequalities (Wang and Lo, 2021). These dynamics challenge core sustainability principles such as equity, justice, and inclusion, and raise concerns about the social sustainability of CE interventions.

In some cases, CE approaches may reproduce or even worsen inequalities. Vulnerable individuals and households often face limited access to circular consumption options, constrained by systemic barriers linked to race, gender, geography, and class (Liu, 2025). Emerging research calls for greater attention to inclusion and justice in the CE, yet gaps remain regarding the capacity of vulnerable groups to engage in circular consumption behaviours (Souza-Piao et al., 2023), (Kirchherr, 2021). Understanding how such behaviours intersect with existing vulnerabilities is crucial to assessing the social impacts of the CE.

While widespread engagement in circular consumption behaviours can advance the Sustainable Development Goals, the ability to adopt them is unevenly distributed among individuals and households (De-León Almaraz et al., 2024). Socioeconomically vulnerable groups may be disproportionately disadvantaged in this transition (Anantharaman, 2018). Vulnerability, extensively studied in the social sciences and climate change literature, refers to an increased risk of harm, disadvantage, or exclusion due to specific socioeconomic and environmental conditions (Rimoldi et al., 2022). This often translates into limited access to essential goods and services such as food, energy, housing, and education. Vulnerability is multifaceted, encompassing overlapping economic, social, environmental, and health-related dimensions (Rimoldi et al., 2022), (Sovacool et al., 2021b).

Economic vulnerability, in particular, reflects financial insecurity that restricts basic needs. In the CE context, socioeconomic vulnerability highlights structural and contextual barriers, including low income, limited education, and geographic isolation, that hinder engagement in circular consumption behaviours (Anantharaman, 2018), (Rimoldi et al., 2022), (Sovacool et al., 2021b). Such constraints may contribute to persistent inequalities in consumption opportunities. Poverty, low education, migration-related challenges, and gender-based barriers all limit individual and household engagement in circular consumption behaviours, ultimately reinforcing broader social disparities (Anantharaman, 2018).

Several studies emphasize the implications of CE initiatives, solutions and opportunities for vulnerable households (Corvellec et al., 2022), (Valenzuela and Böhm, 2017), (Levänen et al., 2023). As low-income populations constitute a large share of the global total (Porpino et al., 2015), their collective behavioural changes hold significant potential to influence sustainability outcomes (Velenturf and Purnell, 2021a), (Monciardini et al., 2024). Porpino et al. (2015) found that food waste among vulnerable Brazilian households stems mainly from overbuying, cooking excess food, and improper storage. Also in Thailand, income disparities have a substantial influence on recycling practices, highlighting the need for supportive policies that assist lower-income communities (Chaiya and Pinthong, 2024). Circular consumption behaviours (Mostaghel and Chirumalla, 2021) applied by households, such as reuse and repair, thus have tangible potential to align social inclusion with CE principles (Velenturf and Purnell, 2021a).

Case studies from Europe and the United States illustrate how urban communities apply CE principles to social innovation, particularly in housing for low-income households (Marchesi and Tweed, 2021). These initiatives integrate not only technological solutions for resource efficiency and waste reduction but also production-consumption practices among households. Similarly, Deutz et al. (2024) show that the geographic distribution of socioeconomic benefits from local CE developments remains uneven, with inclusivity goals largely unmet. McQueen et al. (2022) found that clothing self-repair is the most common practice among Canadian and U.S. consumers, especially women and older individuals, while men rely more on unpaid repair services. Other studies show that highly educated, young men are most active in initiatives such as makerspaces (Edbring et al., 2016), (Shevchenko et al., 2023). Monciardini et al. (2024), examining social cooperatives in Italy, describe a solidarity-based CE model that successfully merges material and social dimensions.

Overall, the CE approach can generate positive social impacts. Nonetheless, it is crucial to consider the constraints they may impose on socioeconomically vulnerable groups. Without equity safeguards, CE initiatives and green consumerism risk perpetuating existing inequalities. This study therefore examines the engagement of households with varying levels of socioeconomic vulnerability in circular consumption behaviours, exploring whether inequalities in adoption exist between vulnerable and non-vulnerable groups. Understanding these dynamics is key to designing policies that foster an inclusive CE advancing both environmental sustainability and social equity.

## 3. Materials and methods

This study investigates the role of households in the CE, with a focus on the differences between vulnerable and non-vulnerable households. The study draws on 2022[1] data from Household Budget Survey (HBS) in Italy and Portugal. It employs a multi-method approach, with each methodology corresponding to a specific sub-research question, as outlined in Table 1. First, descriptive and correlation analyses of the relationships between socioeconomic characteristics and circular

[1] 2022 was the most recent year for which Household Budget Survey data were available when authors began the research presented in this article.

**Table 1**
Study's methodological approach, linking specific methodologies with specific research questions.

| Research question | Method | Data |
|---|---|---|
| RQ1. Which socioeconomic factors predict circular consumption behaviours? | Regression and correlation analysis | Italy and Portugal 2022 HBS socioeconomic and expenditure data |
| RQ2. How can household vulnerability be defined in this context? | Literature review and archetype definition | Italy and Portugal 2022 HBS socioeconomic data |
| RQ3. To what extent do vulnerable households engage in circular consumption behaviours? | Propensity score matching | Italy and Portugal 2022 HBS expenditure data |

consumption; second, the construction of multidimensional vulnerability indicators to categorise households into distinct vulnerability archetypes; and third, a Propensity Score Matching (PSM) model to estimate the effect of vulnerability archetypes on the likelihood of engaging in circular consumption behaviours. This research design enables the triangulation of results of each method, thereby enhancing the robustness and validity of the findings.

This study leverages data from the 2022 HBS, a large-scale, cross-sectional survey conducted by national statistical institutes across European countries under the coordination of Eurostat. It collects detailed information on household income, expenditures, and consumption patterns, typically over a 12-month reference period. Moreover, the HBS also includes socioeconomic data for all the members of the household surveyed. The HBS is designed to provide representative data at the national and regional levels, offering critical insights into how households allocate their resources across 13 macro categories goods and services.

The use of HBS data to investigate individuals' engagement in circular consumption behaviours helps to overcome the limitations associated with the well documented intention-behaviour gap, which jeopardizes primary data collection on circular behaviours (Van Opstal et al., 2025).

The countries chosen as case studies are Italy and Portugal. The selection of these countries was informed by the fact that both are Southern European countries with broadly comparable socioeconomic contexts, which provides a coherent setting for the analysis allowing to minimize the influence of structural confounding factors. The two countries present different policy and regulatory approaches to the CE, particularly regarding consumer behavioural change and citizen engagement. Portugal adopted a national Circular Economy Action Plan in 2017 (European Environment Agency), which explicitly emphasizes the importance of changes in consumption behaviours aligned with CE principles, as well as increased citizen awareness and engagement. By contrast, Italy adopted its National Circular Economy Strategy in 2022 (European Environment Agency), which places stronger emphasis on waste management systems, recycling performance, and economic instruments supporting circular production models, with less explicit attention to behavioural change and citizen engagement in the CE transition.

The two national datasets are analyzed separately to account for differences in data collection methodology.[2] Accordingly, the interpretation of the results focuses on each country individually, examining differences between vulnerable and non-vulnerable households within each case study rather than conducting a direct cross-country comparison. The findings from the two case studies are therefore interpreted in parallel and together inform the overall discussion.

### 3.1. Indicators for circular consumption behaviours and the regression approach

In this study, the actions of repair, maintenance and rental are conceptualized as circular consumption behaviours (Ottelin et al., 2020). The analysis focuses on two of the three critical phases of consumption identified in the literature (Zibell et al., 2025): the purchase phase, during which households may opt for second-hand, refurbished, rented, or shared products instead of buying new ones; and the use phase, where households extend product lifespans through repair and maintenance, thereby avoiding premature disposal. The circular consumption behaviours ascribed to these two phases of consumption are considered to reflect higher levels of circularity, as they preserve both the functionality and economic value of products. In contrast, circular actions taken during the third phase, i.e. end-of-use, are typically associated with lower-value retention, as they aim primarily to recover the value of materials or components rather than maintain product integrity (Van Opstal et al., 2025).

The circular consumption indicators identified within the national HBS datasets and employed in this study are presented in Appendix A. It is important to note that most indicators encompass multiple behaviours (e.g. cleaning, repair, tailoring, hire, maintenance, sewing services, installation, rental), however, due to dataset structure, these behaviours could not be disaggregated further. Additionally, while a single variable was available for some indicators in the Portuguese dataset, multiple variables had to be combined in the Italian dataset to construct the equivalent circular consumption behaviour indicator. These indicators cover only a subset of the product categories that could be object of circular consumption behaviours. However, they do include two key categories highlighted in the EU Circular Economy Action Plan: electronics and ICT, and textiles (European Commission, 2020). Fig. 3 shows the product categories object of circular consumption used in the research design of this study.

Dummy variables were created for each circular consumption behaviour product category, assigning a value of 1 if the household reported any expenditure in the category, and 0 otherwise. This approach reflects the study's focus on whether households engage in circular consumption behaviours, rather than the extent of their engagement as measured by expenditure levels.

This study investigates the socioeconomic drivers of households' circular consumption behaviours (RQ1), adopting a logit regression approach, in line with methods adopted in previous studies such as (Ottelin et al., 2020):

[2] Some differences between the two national HBS datasets: In the Portuguese dataset there is a subset of observations whose household reference person (HRP) is a child, while in the Italian dataset the HRP is always an adult. The variable "size of the living area" was categorical in the Portuguese dataset, continuous in the Italian dataset. The variable reporting the income class was in quintiles in the Portuguese dataset and in deciles in the Italian dataset. The age classes of the variable reporting the age of household members have different intervals under the value of 25 years old and over the value of 75 years old in the Portuguese and Italian datasets. Finally, the circular consumption behaviours categories in the Portuguese dataset are ascribed to a single variable, while in the Italian dataset multiple variables are ascribed to a single circular consumption behaviours category (further explanation in Table 3).

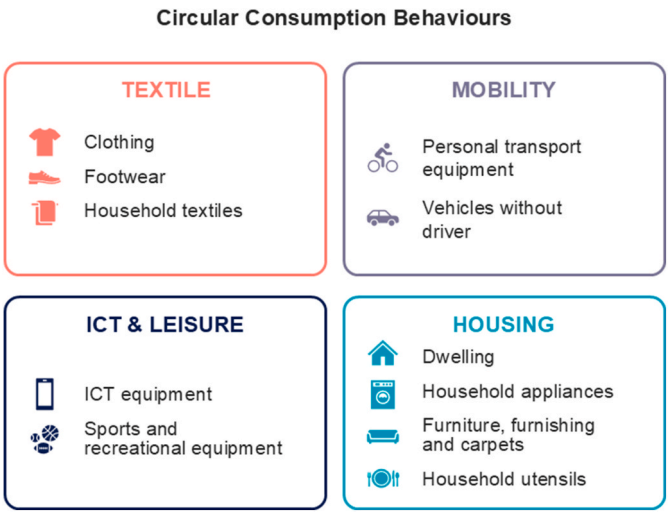


**Fig. 3.** Product categories object of circular consumption used in this study.

$$\text{logit}(P(Y_i = 1)) = \beta_0 + \beta_1 \text{Income}_i + \beta_2 \text{Household size}_i + \beta_3 \text{Age}_i + \beta_4 \text{Education}_i + \beta_5 \text{Gender}_i + u_i$$

where $Y_i$ is a binary dependent variable equal to 1 if household $i$ engages in circular consumption behaviours, and 0 otherwise; $Income_i$ is the income quintile of the household; $Household\ size_i$ is the number of people in the household; $Age_i$ is the age of the HRP; $Education_i$ is the education of the HRP; $Gender_i$ is the gender of the HRP, a dummy variable (1 = male, 0 = female) and finally $\beta_0$ is the intercept, and $\beta_1, \ldots, \beta_5$ are the estimated coefficients, and $u$ is an error term. These individual and household characteristics have been found by previous studies to have an effect on households consumption behaviours (Ottelin et al., 2020), (Whetstone et al., 2020), (Salo et al., 2021).

### 3.2. Vulnerable households' archetypes

Building on existing literature on household archetypes and socioeconomic vulnerability (Whetstone et al., 2020), (ISTAT, 2020), this study draws on 2022 HBS data from Italy and Portugal to identify key indicators that capture multiple dimensions of household socioeconomic vulnerability (RQ2). The following indicators were used to classify vulnerable households into distinct archetypes for further analysis (Table 2): household income, number of adults, presence of children, age of the household reference person (HRP), and per capita living space. While these indicators do not capture the full complexity of socioeconomic vulnerability, because important drivers such as gender, education level, or residential typology could not be included due to data limitations, they nonetheless cover the three core dimensions of vulnerability: economic, social, and structural.

**Table 2**
Indicators used to classify vulnerable households in archetypes, references to previous studies using the same indicators and rationale to use them to characterize vulnerability.

| Indicator | Levels | Reference | Rationale |
|---|---|---|---|
| Income | Low; medium; high | (Sovacool et al., 2021a), ( Whetstone et al., 2020) | Economic dimension of vulnerability |
| Number of adults | 1; >1 | ISTAT (2020) | Social dimension of vulnerability |
| Age HRP | <30; 30–59; ≥ 60 | (Sovacool et al., 2021a), (ISTAT, 2020) | Social dimension of vulnerability |
| Children | No children; With children | (Whetstone et al., 2020), (ISTAT, 2020) | Social dimension of vulnerability |
| Per capita living space | Per capita living area <mean national value; Per capita living area >mean national value | ISTAT (2020) | Structural dimension of vulnerability |

Based on the selected indicators, four distinct archetypes of vulnerable households were constructed. These archetypes reflect different combinations of socio-demographic characteristics and housing conditions associated with disadvantage:

- **Archetype 1**: Single-person households headed by an individual aged over 60, with low income and living in a dwelling with per capita living space below the national average.
- **Archetype 2**: Couples with a HRP aged over 60, with low income and living in a dwelling with per capita living space below the national average.
- **Archetype 3**: Single-parent households headed by a person younger than 30, with at least one child, low income, and living in a dwelling per capita living space below the national average.
- **Archetype 4**: Large households (more than four members) with low income and residing in a dwelling with per capita living space below the national average.

As all four archetypes are designed to capture household socioeconomic vulnerability, certain conditions recur across all of them, i.e. low income and limited per capita living space, while the indicators representing the social dimension of vulnerability vary. The first two archetypes address critical conditions associated with the potential isolation and care needs of the elderly population, measured with reference to households composed exclusively of older persons. In contrast, the remaining two archetypes reflect vulnerabilities linked to childcare: young and adult single-parent households, and large households. These groups are more exposed to situations of economic and social vulnerability, particularly due to the challenges of reconciling family care responsibilities with work (ISTAT, 2020). As previously noted, the constructed archetypes do not explicitly include other drivers of socioeconomic vulnerability such as limited educational level. However, this dimension is indirectly captured through the economic indicator, given the well-documented positive correlation between education and income (with lower education generally associated with lower income). The same rationale applies to unemployment, which, although a direct driver of socioeconomic vulnerability, is partly reflected in the income indicator.

### 3.3. Propensity score matching model

To further investigate the relationship between household vulnerability and engagement in circular consumption behaviours (RQ3), this study employs a Propensity Score Matching (PSM) approach (Rosenbaum and Rubin, 1983). PSM is a widely used quasi-experimental method designed to estimate causal effects when random assignment is not feasible. In our context, the "treatment" is defined as belonging to a vulnerable archetype (i.e., based on household composition, income, and living conditions as described in the previous subsection), and the outcome of interest is the extent of engagement in circular consumption behaviours.

Unlike Difference-in-Differences (DiD) approaches, which rely on panel data and time variation, or Instrumental Variable (IV) methods, which require valid instruments to address endogeneity, PSM addresses selection bias by mimicking random assignment based on observable characteristics. Specifically, it constructs a counterfactual comparison group by matching treated and untreated units (i.e., vulnerable and non-vulnerable households) that are similar in terms of observed covariates. This is achieved by estimating each household's probability of receiving the treatment (its propensity score) conditional on a set of relevant

covariates.

Matching is then performed using these scores to pair treated units with untreated units that have similar propensity scores, thereby balancing the distribution of observed covariates between groups. This process reduces confounding arising from observable differences and allows for a more credible estimation of the treatment effect. Several matching algorithms exist (e.g., kernel matching, caliper matching, Mahalanobis distance matching), but nearest neighbour matching remains the commonly used due to its simplicity and interpretability.

This approach is particularly well-suited to this study research design, as it relies on cross-sectional observational data and aims to isolate the effect of pre-existing household vulnerability, an attribute that cannot be randomly assigned, on the engagement in circular consumption behaviours. By approximating a randomized control setting, PSM allows to draw more credible inferences about how vulnerability may influence the engagement in circular consumption behaviours. Defined as the probability of being vulnerable, given a set of observed covariates, the following logistic regression model is firstly run to find, for each treated observation, a counterfactual as similar as possible based on observable characteristics, so that the treated observation and the counterfactual differ exclusively because of the treatment (Heckman et al., 1998):

$$P(T_i = 1|X_i) = \text{logit}(X_i)$$

where T is the treatment indicator for unit *i*, i.e. belonging to any of the 4 vulnerability archetypes constructed, and $X_i$ is the vector of observed covariates for unit *i* that affect the probability of being treated. To compare the units with similar propensity scores, the one-to-one nearest-neighbour method (Dehejia and Wahba, 2002) has been chosen. It has been used the nearest neighbour matching increasing the comparison ratio to 5:1 to avoid data loss due to the small proportion of treated observations, while still remaining within acceptable levels of standardized mean differences.

After the matching, on the new dataset including the same number of treated and untreated observations, the Average Treatment Effect on the Treated (ATT) is then computed as:

$$ATT = E(Y_i(1)|T_i = 1) - E(Y_i|T_i = 1) \quad (0)$$

where $Y_i(1)$ denotes the engagement in circular consumption behaviours for household *i* under the condition of vulnerability $(T_i=1)$, and $Y_i(0)$ denotes the potential level of engagement for the same household if it were not vulnerable $(T_i=0)$. The treatment indicator $T_i$ takes the value 1 for vulnerable households and 0 otherwise. The first term, $E(Y_i(1)|T_i=1)$, reflects the observed average probability of engagement in circular consumption behaviours among vulnerable households. The second term, $E(Y_i(0)|T_i=1)$, corresponds to the counterfactual average engagement probability that these same households would have demonstrated if they had not been vulnerable, which is not directly observable and is instead estimated using propensity score matching. The ATT thus captures the causal effect of vulnerability status on circular consumption engagement for those households that are actually vulnerable.

While Propensity Score Matching (PSM) helps mitigate selection bias based on observed characteristics, it has important limitations. Most notably, PSM cannot account for unobserved confounders: variables that influence both treatment assignment and the outcome but are not included in the model. As a result, omitted variable bias may still arise if important variables are not considered. Additionally, the quality of the matching process depends heavily on the choice of covariates and the specification of the propensity score model. Poor overlap between treated and untreated units (i.e., limited common support) can lead to the exclusion of observations and reduce external validity.

## 4. Results

### 4.1. Descriptive statistics of households and circular consumption behaviours in Italy and Portugal

Table 3 gives an overview of the national households' samples used in this study. Similarly, both countries show a generally aging population among HRPs. However, Portugal has a higher share of younger HRPs, particularly in the 15–24 age group (11.9% vs. only 0.4% in Italy), suggesting either earlier household formation or different identification of the HRP in the HBS methodology. The two countries differ significantly in the distribution of educational levels. The proportion of HRP with no formal education is more than twice as high in Portugal (5.9%) as in Italy (2.1%). In Portugal, primary school education is by far the most common (33.4%), while in Italy this group makes up only 14.3%. Conversely, Italy has a much higher share of HRPs with high school (upper secondary) education (38.1%) compared to Portugal (21.9%). The gender gap is more pronounced in Italy, where HRP are more commonly men, while Portugal shows a more balanced gender distribution, with females representing 53.2% of HRPs. Moreover, in Portugal households are slightly larger than in Italy, but living in smaller spaces (see Table 4).

Table 5 provides an overview of how diffused circular consumption behaviours among Italian and Portuguese households are, and it provides also detailed figures of how diffused circular consumption behaviours related to specific product categories. Overall, Portuguese households appear significantly more engaged in circular consumption behaviours (62.52%) compared to Italian households (30.98%). However, this striking difference is strongly influenced by the notably high percentage of Portuguese households undertaking maintenance and repair of personal transport equipment (51.11%), compared to just 13.08% in Italy. The Portuguese notably high shares may be attributed to Portugal's mandatory vehicle safety checks, which legally oblige households to perform regular vehicle maintenance every two years.[3] But this does not explain the discrepancy between Portugues and Italian

**Table 3**
Descriptive statistics of categorical socioeconomic variables, proportion for each country.

| Variable | Level | Italy | Portugal |
|---|---|---|---|
| Age HRP | 15-24 | 0.4 | 11.9 |
| | 25-29 | 1.7 | 4.5 |
| | 30-34 | 4.0 | 4.4 |
| | 35-39 | 5.6 | 4.9 |
| | 40-44 | 7.0 | 7.1 |
| | 45-49 | 8.8 | 9.0 |
| | 50-54 | 10.3 | 8.9 |
| | 55-59 | 11.3 | 9.3 |
| | 60-64 | 10.7 | 9.4 |
| | 65-69 | 10.1 | 8.9 |
| | 70-74 | 10.2 | 7.8 |
| | 75+ | 19.9 | 13.9 |
| Educational level HRP | No degree | 2.1 | 5.9 |
| | Primary school | 14.3 | 33.4 |
| | Middle school (lower secondary education) | 28.2 | 18.3 |
| | High school (upper secondary education) | 38.1 | 21.9 |
| | University degree and postgraduate education | 17.3 | 20.5 |
| Gender HRP | Male | 62.6 | 46.8 |
| | Female | 37.4 | 53.2 |

[3] The figures of car ownership rates available from Eurostat for Portugal in 2022 are of 511 cars per 1000 inhabitants (Eurostat), roughly explaining the rate of maintenance and repair of personal transport equipment.

**Table 4**
Descriptive statistics socioeconomic variables, mean values. SD in brackets.

| Variable | Italy | Portugal |
|---|---|---|
| Household size | 2.211 | 2.854 |
| | (1.168) | (1.199) |
| Per capita living area (sqm) | 55.58 | 53.53 |
| | (32.40) | (31.23) |

**Table 5**
Share of households that engage in circular consumption behaviours, in general, and for each circular consumption product category. The wording of the circular consumption behaviours reported for each product category is the same used in the Household Budget Survey.

| | Indicator | Italy | Portugal |
|---|---|---|---|
| | **Total circular consumption behaviours** | 30.98% | 62.52% |
| | Cleaning, repair, tailoring and hire of **clothing** | 9.16% | 6.85% |
| | Cleaning, repair, and hire of **footwear** | 1.32% | 2.14% |
| | Materials for the maintenance and repair of the **dwelling** | 9.85% | 20.64% |
| | Repair, installation and hire of **furniture, furnishings and loose carpets** | 0.36% | 0.90% |
| | Repair, hire and sewing services of **household textiles** | 2.07% | 1.00% |
| | Repair, installation and hire of **household appliances** | 2.16% | 4.86% |
| | Maintenance and repair of **personal transport equipment** | 13.08% | 51.11% |
| | Repair and rental of **information and communication equipment** | 1.24% | 1.66% |
| | Hire and repair of **equipment for sport, camping and open-air recreation** | 0.70% | 0.11% |
| | Repair and rental of **glassware, crockery, and other household utensils** | 0.21% | 0.07% |
| | Rental of **vehicles without a driver** | 0.66% | 0.75% |

figures since Italy has the same obligation with the same frequency.[4] Another explanation could be that the Portuguese vehicle fleet is overall older than the Italian one hence requiring more maintenance.[5] Beyond personal transport maintenance, differences in adoption rates for other circular behaviours are less marked, though Portugal still shows higher involvement in dwelling maintenance (20.64%) compared to Italy (9.85%), while Italy displays slightly higher engagement in clothing-related circular behaviours (9.16% compared to 6.85% in Portugal). Nevertheless, the categories of personal transport equipment, dwelling maintenance, and clothing remain the three primary product categories where most circular consumption behaviours occur. Interestingly, despite electronics and ICT being strategically prioritized in the EU Circular Economy Action Plan, figures for the repair of household appliances and ICT equipment remain notably low in both countries.

### 4.2. Socioeconomic drivers of circular consumption behaviours

The logistic regression results for Italy (Table 6) indicate that both

**Table 6**
Logistic regression results – engagement of Italian households in circular consumption behaviours.

| Variable | Estimate | Std. Error |
|---|---|---|
| **Income Quintile** | | |
| *Base case: First income quintile* | | |
| Second income quintile | 0.250*** | (0.049) |
| Third income quintile | 0.541*** | (0.048) |
| Fourth income quintile | 0.732*** | (0.049) |
| Fifth income quintile | 0.969*** | (0.051) |
| **Household Size** | 0.019 | (0.013) |
| **Age of HRP** | | |
| *Base case: 18-24 years old* | | |
| 25-29 | 0.141 | (0.253) |
| 30-34 | 0.096 | (0.241) |
| 35-39 | 0.204 | (0.238) |
| 40-44 | 0.204 | (0.237) |
| 45-49 | 0.238 | (0.236) |
| 50-54 | 0.355 | (0.235) |
| 55-59 | 0.365 | (0.235) |
| 60-64 | 0.450. | (0.235) |
| 65-69 | 0.300 | (0.235) |
| 70-74 | 0.289 | (0.236) |
| > 75 | 0.091 | (0.235) |
| **Education of HRP** | | |
| *Base case: no degree* | | |
| Primary | 0.443** | (0.137) |
| Lower Secondary | 0.687*** | (0.136) |
| Upper Secondary | 0.875*** | (0.136) |
| University | 1.013*** | (0.138) |
| **Gender of HRP** | | |
| *Base case: Male* | | |
| Female | −0.203*** | (0.029) |
| **Constant** | −2.365*** | (0.269) |
| **Model Statistics** | | |
| Observations | 28,416 | |
| Null Deviance | 35,175 | |
| Residual | 33,597 | |
| Deviance AIC | 33,635 | |

*Note:* $.p < 0.1, *p < 0.05, **p < 0.01, ***p < 0.001$.

socioeconomic status and demographic factors influence the likelihood of households of engaging in circular consumption behaviours. Higher income and especially higher educational attainment are strongly associated with increased odds of circular consumption behaviours. Women-led households are significantly less likely to report such behaviours. The logistic regression results for Portugal (Table 7) show that households with higher income and larger household sizes are significantly more likely to engage in circular consumption behaviours. Education is also a strong positive predictor: having attended any grade of school is associated with higher probability of engaging in circular consumption behaviours. In contrast to the Italian model, age has a significant and negative relationship with circular consumption behaviour, particularly over the age of 75, indicating lower engagement in circular consumption behaviours among older individuals (i.e. HRP). Differently from the results of the Italian model, gender does not show a statistically significant effect in Portugal. In both countries, households with higher incomes and higher levels of education are more likely to engage in circular consumption behaviours. Age and gender also appear to influence participation in the CE, though their effects vary by country: age acts as a barrier in Portugal, while gender (specifically, being female) is associated with lower engagement in Italy. Overall, households that have higher income, better education, younger age, and male household heads are more likely to engage in circular consumption behaviours, highlighting socioeconomic inequalities in the current approach to the CE. A possible explanation of the effect that income has on circular consumption behaviour may be related to product ownership: especially considering durable goods, e.g. vehicles, dwelling (see Tables 8 and 9 for results related to the 3 product categories: personal vehicles, clothing, dwelling), having more purchase power may lead to the opportunity of purchase and own a product, and hence engaging in

[4] Italy has even higher car ownership rates: 694 cars per 1000 inhabitants in 2022 (Eurostat).

[5] Portugal has a higher share of vehicles older than 5 years old (78%) compared to Italy (74%) (File:F5 Passenger cars by age, 2024).

**Table 7**
Logistic regression results – engagement of Portuguese households in circular consumption behaviours.

| Variable | Estimate | Std. Error |
|---|---|---|
| **Income Quintile** | | |
| *Base case: First income quintile* | | |
| Second income quintile | 0.446*** | (0.041) |
| Third income quintile | 0.611*** | (0.042) |
| Fourth income quintile | 0.913*** | (0.044) |
| Fifth income quintile | 1.045*** | (0.047) |
| **Household Size** | 0.211*** | (0.013) |
| **Age of HRP** | | |
| *Base case: 15-24 years old* | | |
| 25-29 | −0.123. | (0.076) |
| 30-34 | −0.127. | (0.076) |
| 35-39 | −0.215** | (0.073) |
| 40-44 | −0.137* | (0.065) |
| 45-49 | 0.015 | (0.062) |
| 50-54 | 0.022 | (0.063) |
| 55-59 | 0.090 | (0.063) |
| 60-64 | 0.085 | (0.065) |
| 65-69 | 0.011. | (0.067) |
| 70-74 | −0.087 | (0.070) |
| 75+ | −0.293*** | (0.064) |
| **Education of HRP** | | |
| *Base case: no degree* | | |
| Primary | 0.383*** | (0.060) |
| Lower Secondary | 0.597*** | (0.068) |
| Upper Secondary | 0.602*** | (0.069) |
| University | 0.622*** | (0.072) |
| **Gender of HRP** | | |
| *Base case: Male* | | |
| Female | −0.051* | (0.027) |
| **Constant** | −1.272*** | (0.092) |
| **Model Statistics** | | |
| Observations | 25,180 | |
| Null Deviance | 33,312 | |
| Residual | 31,538 | |
| Deviance AIC | 31,576 | |

*Note:* $.p < 0.1, *p < 0.05, **p < 0.01, ***p < 0.001$.

circular consumption behaviours like repairing and maintaining them. The positive correlation between income and the likelihood of engaging in circular consumption behaviours may also be explained by the fact that the HBS data capture only expenditures that households have incurred for repair, maintenance, or rental services, thereby overlooking cases in which these actions take place informally and are not financially recorded. While education and younger age may be associated with pro-environmental preferences, ultimately leading to engaging in circular consumption practices, as well as better access to circularity services, e.g. through digital platforms.

This study further investigates the probability of engagement in circular consumption behaviours related to three specific product categories: repair, maintenance and rental of personal transport equipment, clothing, and dwelling (see Table 5). In Italy (Table 8), higher household income is significantly associated with a greater likelihood of realizing circular consumption in all three product categories, with the strongest effect observed for clothing-related behaviours. Education of the household reference person (HRP) also emerges as a strong and consistent predictor, confirming the result of the overall model, with the probability of engaging in circular consumption behaviours increasing steadily across higher education levels and peaking for university-educated individuals. The effect of household size differs by product category: larger households are more likely to adopt circular consumption behaviours related to personal transport equipment and dwelling, whereas the opposite holds for clothing, where household size is negatively associated with circular consumption behaviour. Gender inequalities are evident for personal transport equipment and dwelling, with female-headed households exhibiting a lower propensity to engage in circular behaviours in these categories; however, no significant gender effect is observed for clothing. In contrast, the age of the HRP does not significantly predict circular behaviour adoption in any of the three model's specifications. Overall, the results of the three model specifications confirm the results of the overall model, except for the effect of the household size.

The results for product specific categories of circular consumption behaviours in Portugal reveal both consistent and category-specific determinants of household engagement in circular consumption behaviours (Table 9). Household income emerges as a strong and positive predictor across all three product categories with the effect being largest for personal transport equipment. Household size is also positively associated with the adoption of circular consumption behaviours in all categories. Distinct patterns appear regarding age. Compared to the reference group (15–24 years old), older age groups, particularly the oldest (75+), show a significantly lower likelihood of adopting circular consumption behaviours in all product categories, but for clothing this trend is showed also by younger age groups (up to 44 years old). Education of the HRP is a robust and positive predictor for circular consumption behaviours applied to personal transport equipment, with the probability of adoption rising consistently with higher education levels. However, the effect of education is weaker and mostly not significant for clothing and dwelling. Gender of the HRP does not significantly influence circular consumption behaviour in any category, indicating no substantial difference between male- and female-headed households and confirming the result of the overall model (Table 7).

### 4.3. Vulnerability archetypes

Fig. 4 illustrates the presence of the different vulnerable archetypes in both case study countries. Overall, Portugal exhibits a slightly higher presence of vulnerable households within its overall population (8.6%) compared to Italy (7.2%). Given that the household vulnerability archetypes developed in this study depict socioeconomic and housing-related disadvantages, these figures indicate a concerning overall social situation in both countries. Household vulnerability archetype 1, characterized by single-person households headed by individuals over 60 with low income and restricted living space, is more common in Italy than in Portugal, although it remains relatively uncommon in both countries. Similarly, vulnerable households classified as archetype 2 are also more diffused in Italy than in Portugal. Notably, households headed by individuals over 60 represent 51% of all Italian households, while in Portugal, this proportion is 40% (see Table 3 for reference). Archetype 3, defined as single-parent households headed by individuals younger than 30, exhibits minimal representation in both countries and constitutes the least prevalent category overall. Finally, Archetype 4, comprising large households with more than four members experiencing low income and inadequate living space, shows a considerable discrepancy, being significantly more common in Portugal than in Italy. This difference aligns with the observation that the average household size in Portugal exceeds that in Italy (see Table 4 for reference). In summary, Archetype 4 (large households experiencing poverty) is the most prevalent vulnerability archetype in Portugal, whereas in Italy, Archetype 2 (elderly couples living under disadvantaged conditions) predominates.

### 4.4. Engagement of vulnerable households in circular consumption behaviours

Fig. 5 presents the overall share of households engaging in circular consumption behaviours in the two case study countries, Italy and Portugal, also disaggregated by household vulnerability status as defined in this study. Overall, in Portugal a higher share of households, irrespective of being vulnerable or not, reported engaging in circular consumption behaviours compared to Italian households. In fact, when considering the total household population (i.e. the combined sample of vulnerable and non-vulnerable households), 63% of Portuguese households and 31% of Italian households reported circular consumption

**Table 8**
Logistic Regression Results – Engagement of Italian Households in Circular Consumption Behaviours related to the products: personal vehicles, clothing, dwelling.

| Dependent variable | Personal transport equipment | | Clothing | | Dwelling | |
|---|---|---|---|---|---|---|
| | Estimate | Std. Error | Estimate | Std. Error | Estimate | Std. Error |
| **Income Quintile** | | | | | | |
| *Base case: First income quintile* | | | | | | |
| Second income quintile | 0.427*** | (0.074) | 0.321*** | (0.088) | 0.044 | (0.078) |
| Third income quintile | 0.650*** | (0.072) | 0.613 *** | (0.085) | 0.347*** | (0.075) |
| Fourth income quintile | 0.828*** | (0.072) | 0.785 *** | (0.086) | 0.385*** | (0.076) |
| Fifth income quintile | 0.919*** | (0.075) | 1.082 *** | (0.088) | 0.550*** | (0.079) |
| **Household Size** | 0.042** | (0.017) | −0.070 ** | (0.021) | 0.084*** | (0.019) |
| **Age of HRP** | | | | | | |
| *Base case: 15-24 years old* | | | | | | |
| 25-29 | 0.112 | (0.379) | −0.170 | (0.407) | 0.180 | (0.378) |
| 30-34 | 0.373 | (0.359) | −0.236 | (0.385) | −0.122 | (0.364) |
| 35-39 | 0.343 | (0.356) | −0.356 | (0.382) | 0.065 | (0.357) |
| 40-44 | 0.226 | (0.355) | −0.179 | (0.379) | 0.155 | (0.355) |
| 45-49 | 0.381 | (0.353) | 0.006 | (0.376) | 0.019 | (0.354) |
| 50-54 | 0.427 | (0.353) | 0.087 | (0.375) | 0.111 | (0.353) |
| 55-59 | 0.393 | (0.352) | 0.189 | (0.374) | 0.090 | (0.353) |
| 60-64 | 0.494 | (0.352) | 0.253 | (0.374) | 0.115 | (0.353) |
| 65-69 | 0.316 | (0.353) | 0.314 | (0.374) | 0.002 | (0.354) |
| 70-74 | 0.399 | (0.353) | 0.210 | (0.375) | −0.136 | (0.355) |
| 75+ | −0.075 | (0.353) | 0.124 | (0.374) | −0.296 | (0.354) |
| **Education of HRP** | | | | | | |
| *Base case: no degree* | | | | | | |
| Primary | 0.498* | (0.237) | 0.067 | (0.226) | 0.571* | (0.236) |
| Lower Secondary | 0.829*** | (0.233) | 0.384. | (0.222) | 0.642** | (0.235) |
| Upper Secondary | 0.964*** | (0.233) | 0.722 ** | (0.221) | 0.680** | (0.235) |
| University | 0.901*** | (0.236) | 1.054 *** | (0.224) | 0.617** | (0.239) |
| **Gender of HRP** | | | | | | |
| *Base case: Male* | | | | | | |
| Female | −0.271*** | (0.040) | −0.045 | (0.046) | −0.286*** | (0.046) |
| Constant | −3.737 *** | (0.420) | −3.707*** | (0.431) | −3.408*** | (0.420) |
| **Model Statistics** | | | | | | |
| Observations | 28,416 | | 28,416 | | 28,416 | |
| Null Deviance | 22,046 | | 17,399 | | 18,292 | |
| Residual Deviance | 21,239 | | 16,704 | | 17,879 | |
| AIC | 21,277 | | 16,742 | | 17,917 | |

*Note:* $.p < 0.1$, $*p < 0.05$, $**p < 0.01$, $***p < 0.001$.

behaviours. In both countries, non-vulnerable households exhibited higher participation rates than vulnerable ones. Specifically, in Portugal, 63% of non-vulnerable households and 52% of vulnerable households reported engaging in circular behaviours, while in Italy the corresponding figures were 31% and 20%, respectively.

This study aimed to investigate the impact of household vulnerability condition on the engagement in circular consumption behaviours. To do that, it employed the PSM approach, which consents to estimate causal effects when random assignment is not feasible. To do that, it constructs a counterfactual comparison group by matching vulnerable and non-vulnerable households, that are statistically similar across observables covariates while differing only in their vulnerability condition. By comparing vulnerable households with the most similar non-vulnerable households the effect of vulnerability on the propensity to engage in circular consumption behaviours can be assessed (see section 3.4 for more details about methodology). Figs. 6 and 7 present the covariate balance before and after the matching respectively for Italy and for Portugal, showing a marked improvement in balance between the vulnerable and non-vulnerable Italian households after propensity score matching. Before matching (red dots), several covariates displayed substantial imbalance, with standardized mean differences (SMDs) exceeding the conventional threshold of 0.1 in absolute value. After matching (blue dots), almost all covariates fall well within the ±0.1 SMD threshold, indicating that the matching procedure was effective in reducing systematic differences between the groups.

As showed in Table 10 for the Italian sample, household vulnerability is consistently associated with a lower propensity to engage in circular consumption behaviours in general, as well as across all circular consumption behaviour product categories. All effects are statistically significant, except for the circular consumption behaviours of the dwelling product category, where the effect is smaller in magnitude and not statistically significant. These results indicate that vulnerability is a substantial barrier to adopting circular consumption behaviours, especially in domains such as clothing and personal transport.

Table 11 presents the results for the Portuguese sample, revealing trends similar to those observed in the Italian case. Overall, household vulnerability is associated with a lower propensity to engage in circular consumption behaviours, including circular consumption within the personal transport equipment category. For clothing, the negative effect is marginally significant, while for the dwelling category the effect is small and not statistically significant.

## 5. Discussion and conclusion

This study was not designed as comparative research, the use of two different case studies reveals both common patterns and, more interestingly, distinct and complementary aspects of households' engagement in the CE. While the study primarily focused on a specific category of households, i.e. vulnerable households as conceptualized herein, the broader analysis of circular consumption behaviours across all households, irrespective of their vulnerability status, highlights that the diffusion of such behaviours remains limited, particularly in Italy. In fact, while in Portugal more than half of the population engages in at least one circular consumption behaviour (as defined in this study), in Italy this share is below one third. This finding should be interpreted in light of the different national policy and regulatory frameworks: Portugal places some emphasis on behavioural change and citizen engagement in its CE transition, whereas Italy's framework focuses more strongly on waste management systems and circular production models. The results also suggest that there is still considerable potential to

**Table 9**
Logistic Regression Results – Engagement of Portuguese Households in Circular Consumption Behaviours related to the products: personal vehicles, clothing, dwelling.

| Dependent variable | Personal transport equipment | | Clothing | | Dwelling | |
|---|---|---|---|---|---|---|
| | Estimate | Std. Error | Estimate | Std. Error | Estimate | Std. Error |
| **Income Quintile** | | | | | | |
| *Base case: First income quintile* | | | | | | |
| Second income quintile | 0.442*** | (0.042) | 0.331 | (0.091) | 0.254*** | (0.051) |
| Third income quintile | 0.627*** | (0.043) | 0.427 | (0.091) | 0.297*** | (0.052) |
| Fourth income quintile | 0.942*** | (0.044) | 0.406 | (0.092) | 0.347*** | (0.053) |
| Fifth income quintile | 1.053*** | (0.046) | 0.695 | (0.093) | 0.339*** | (0.056) |
| **Household Size** | 0.184*** | (0.012) | 0.148 | (0.023) | 0.122 *** | (0.014) |
| **Age of HRP** | | | | | | |
| *Base case: 15-24 years old* | | | | | | |
| 25-29 | −0.064 | (0.072) | −0.385 *** | (0.141) | 0.010 | (0.085) |
| 30-34 | −0.079 | (0.072) | −0.262. | (0.138) | 0.065 | (0.085) |
| 35-39 | −0.160* | (0.070) | −0.407** | (0.140) | −0.040 | (0.083) |
| 40-44 | −0.088 | (0.062) | −0.237 * | (0.115) | −0.035 | (0.073) |
| 45-49 | 0.038 | (0.058) | −0.013 | (0.103) | −0.010 | (0.068) |
| 50-54 | 0.061 | (0.059) | −0.169 | (0.109) | −0.013 | (0.070) |
| 55-59 | 0.153** | (0.060) | −0.017 | (0.108) | 0.042 | (0.070) |
| 60-64 | 0.06 | (0.061) | 0.026 | (0.112) | 0.051 | (0.072) |
| 65-69 | 0.048 | (0.064) | 0.154 | (0.115) | 0.039 | (0.076) |
| 70-74 | −0.118. | (0.068) | −0.125 | (0.131) | −0.086 | (0.082) |
| 75+ | −0.339*** | (0.063) | −0.287 * | (0.123) | −0.221 ** | (0.076) |
| **Education of HRP** | | | | | | |
| *Base case: no degree* | | | | | | |
| Primary | 0.471*** | (0.065) | 0.062 | (0.141) | 0.108 | (0.078) |
| Lower Secondary | 0.669*** | (0.072) | 0.211 | (0.151) | 0.097 | (0.085) |
| Upper Secondary | 0.711*** | (0.073) | 0.274. | (0.152) | 0.031 | (0.086) |
| University | 0.702*** | (0.074) | 0.377* | (0.154) | −0.083 | (0.089) |
| **Gender of HRP** | | | | | | |
| *Base case: Male* | | | | | | |
| Female | −0.074*** | (0.026) | 0.015 | (0.050) | −0.029 | (0.031) |
| Constant | −1.781*** | (0.026) | −3.620 *** | (0.189) | −1.941*** | (0.111) |
| **Model Statistics** | | | | | | |
| Observations | 25,180 | | 25,180 | | 25,180 | |
| Null Deviance | 34,894 | | 12,588 | | 25,646 | |
| Residual Deviance | 33,010 | | 12,373 | | 25,469 | |
| AIC | 33,048 | | 12,411 | | 25,507 | |

*Note:* $.p < 0.1$, $*p < 0.05$, $**p < 0.01$, $***p < 0.001$.

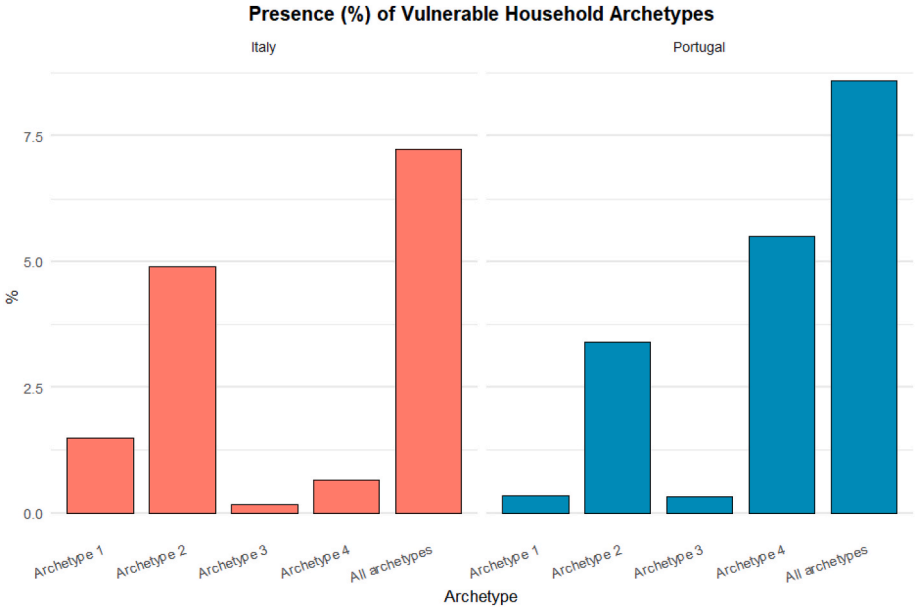


**Fig. 4.** Presence in percentage of vulnerable households across the two case study countries. Figures shown for each archetype, and for all archetypes together.

improve overall household engagement in the CE, especially in Italy. At the same time, the relatively higher figure observed for Portugal is largely driven by behaviours related to the "personal transport equipment" product category. This may reflect the fact that vehicles tend to be older, and households lack the financial resources to purchase newer, less polluting cars. Previous studies have described this situation as a CE rebound effect: products and materials are indeed used for longer periods, thereby applying circular consumption principles, but at the

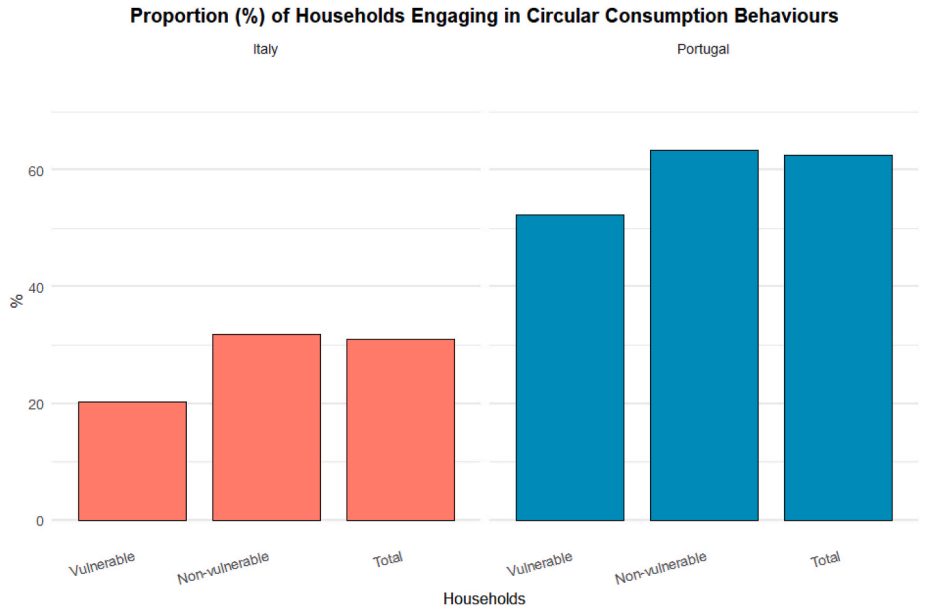


**Fig. 5.** Proportion of households engaging in circular consumption behaviours in each case study country. The figure shows percentages for non-vulnerable and vulnerable households, as defined in this study, as well as for the total household population (sum of vulnerable and non-vulnerable households). Percentages are calculated within each respective category.

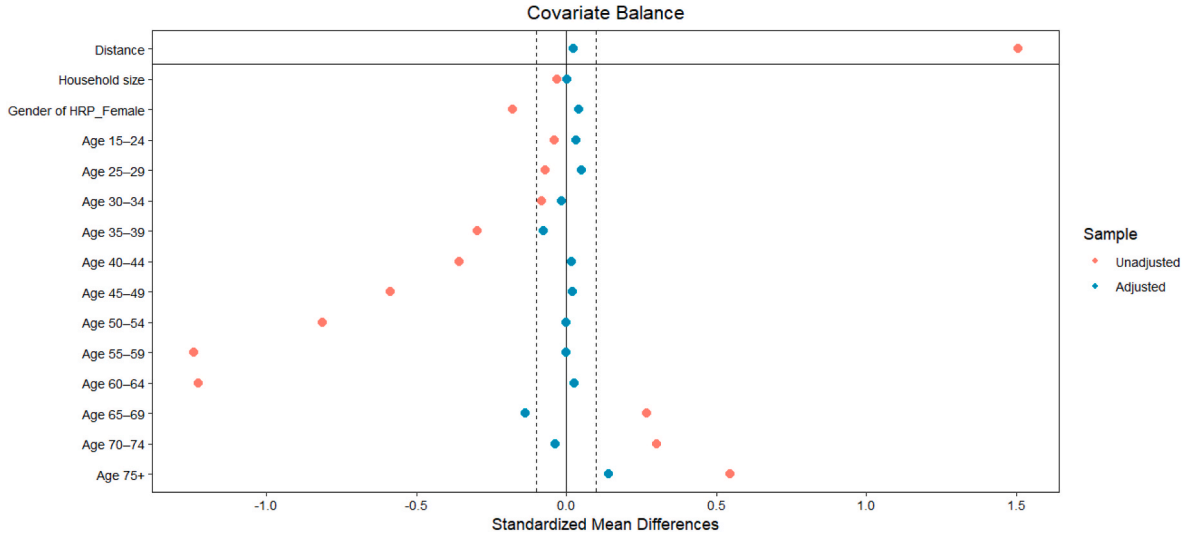


**Fig. 6.** Covariate balance before and after propensity score matching for the Italian dataset. Standardized mean differences are displayed for each covariate, with the vertical dashed line indicating the conventional threshold of 0.1, beyond which imbalance is considered potentially problematic. Covariate labels correspond to the households' socioeconomic characteristics used as matching variables.

expense of higher environmental impacts due to increased pollution (Zink and Geyer, 2017). Another consideration is that certain products, such as vehicles and buildings, are subject to legal maintenance requirements. In these cases, specific circular consumption behaviours (as defined in this study) are effectively embedded in the conditions of product use rather than adopted voluntarily. Consequently, the results for the "personal transport equipment" category, the product category that shows higher engagement of households in circular consumption behaviours, should be interpreted with caution and not directly compared with circular behaviours that depend on voluntary consumer choices. Conversely, circular consumption behaviours may be hindered by the fact that some linear consumption behaviours are structurally embedded in other product categories, such as ICT equipment, due to various forms of obsolescence. This may be planned, when components are designed to wear prematurely, are difficult to replace, or software updates degrade performance or drop support; or economic, when maintenance and repair costs exceed, or are perceived to exceed, the cost of purchasing a new product (Sierra-Fontalvo et al., 2023). This dynamic helps explain why, despite the strategic prioritization of electronics and ICT products in the EU Circular Economy Action Plan, the repair rates for household appliances and ICT equipment remain notably low in both case study countries.

Regarding the socioeconomic drivers of circular consumption behaviours and the differences among vulnerable and non-vulnerable households, this study finds that in both case study's countries, higher income and higher education are associated with higher probability of the household to engage in circular consumption behaviours. These results confirm what found by Ottelin et al. (2020), using the same HBS data but from 2010, meaning that in a decade the positive correlation between income and spending for circular consumption services has not

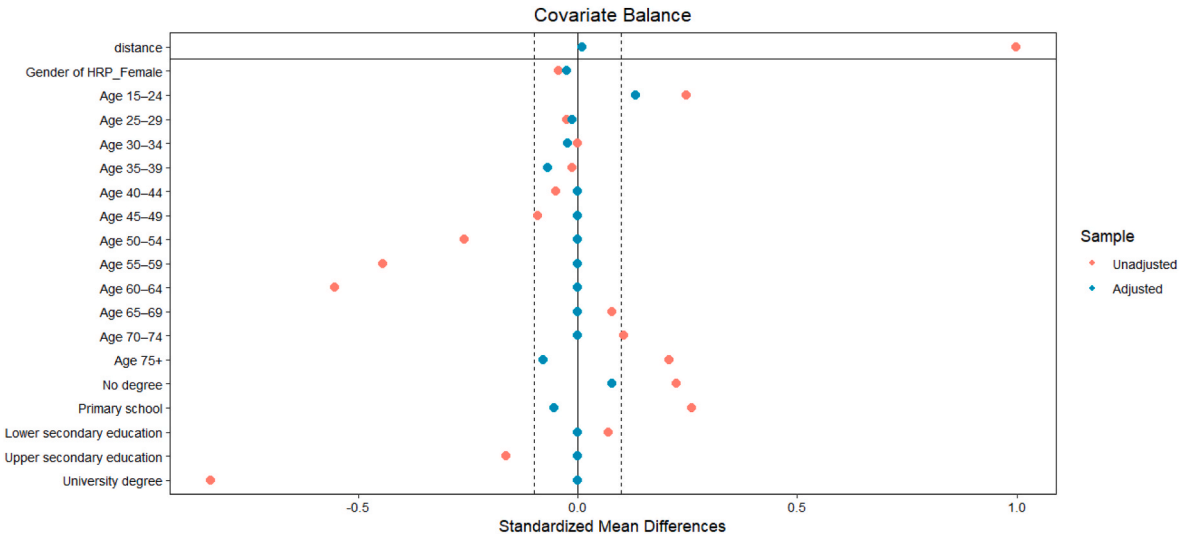


**Fig. 7.** Covariate balance before and after propensity score matching for the Portuguese dataset. Standardized mean differences are displayed for each covariate, with the vertical dashed line indicating the conventional threshold of 0.1, beyond which imbalance is considered potentially problematic. Covariate labels correspond to the households' socioeconomic characteristics used as matching variables.

**Table 10**
Estimated ATT from logistic regression across model specifications, Italian dataset.

| Variable | Circular Consumption Behaviour | | Personal Transport Equipment | | Clothing | | Dwelling | |
|---|---|---|---|---|---|---|---|---|
| | Estimate | Std. Error | Estimate | Std. Error | Estimate | Std. Error | Estimate | Std. Error |
| Household vulnerability | −0.563 *** | (0.064) | −0.547 *** | (0.094) | −0.899 *** | (0.124) | −0.132 | (0.096) |

*Significance codes:* ***$p < 0.001$, **$p < 0.01$, *$p < 0.05$, †$p < 0.1$.

**Table 11**
Estimated ATT from logistic regression across model specifications, Portuguese dataset.

| Variable | Circular Consumption Behaviour | | Personal Transport Equipment | | Clothing | | Dwelling | |
|---|---|---|---|---|---|---|---|---|
| | Estimate | Std. Error | Estimate | Std. Error | Estimate | Std. Error | Estimate | Std. Error |
| Household vulnerability | −0.232 *** | (0.049) | −0.318 *** | (0.0504) | −0.184. | (0.109) | 0.010 | (0.061) |

*Significance codes:* ***$p < 0.001$, **$p < 0.01$, *$p < 0.05$, †$p < 0.1$.

varied. The HBS data used for this study did not consent to observe circular consumption behaviours that have not been officially financially accounted, e.g. informal repair services such as self-repair, and this data limitation may explain the finding regarding the positive correlation between income and the likelihood of engaging in circular consumption behaviours. Shadow economy is an important phenomenon, especially in Italy and in Portugal even more. A former study (Van Opstal et al., 2025) estimated the presence and size of informal CE activities for the first time in a European country to outline policy recommendations to take into account social implications of the CE (Van Opstal et al., 2025). Collecting primary data through surveys would allow future studies to capture information on both formal and informal circular consumption behaviours. However, any survey design should account for and mitigate potential intention–action biases. Another possible explanation of the positive effect found that income has on circular consumption behaviour may be related to product ownership: especially considering durable goods, e.g. vehicles and dwelling that are two out of the three product categories this study further investigated, having more purchase power may lead to higher likelihood of purchasing and owning a product, subsequently affecting the possibility to engage in circular consumption behaviours in the two following stages of consumption, use and end of use.

This study finds that education is also a strong positive predictor of the engagement in circular consumption behaviours. This relationship may be explained by the fact that more educated individuals are generally more exposed to information concerning environmental issues, resource scarcity, climate change, and sustainability, which fosters higher levels of environmental literacy. In turn, this may lead to the development of stronger environmental values and pro-environmental attitudes (Leal et al., 2024), (Chekima et al., 2016). A similar mechanism could account for the effect of younger age, combined with the fact that some circular consumption behaviours are facilitated by digital platforms, which younger individuals may find easier to access and use compared to older individuals (Paro et al., 2021).

A general effect of gender inequality was also observed, with women-led households being less engaged in circular consumption behaviours, contrary to the findings of Ottelin et al. (2020) and other studies exploring the effect of gender on sustainable consumption and finding that women hold stronger attitudes towards the environment than men (Chekima et al., 2016), (Costa Pinto et al., 2014). This discrepancy may be partly due to the structure of the HBS data, which identify the gender of the HRP but not of the individual(s) who actually implement circular consumption behaviours. Consequently, the consumption data, both circular and linear, refer to the household as a unit rather than to specific household members. Another possible explanation for this divergence is that most previous studies examine intentions to engage in sustainable behaviours, whereas the present analysis focuses on actual behaviours, as recorded in the HBS, thereby reflecting the well-documented

intention–behaviour gap in sustainable consumption.

This study further investigated the impact of being vulnerable, defined in this study as being at increased risk of harm, disadvantage or exclusion due to specific socioeconomic and structural conditions, on the likelihood of engagement in circular consumption behaviours. More specifically, vulnerable households in this study are those combining varying socio-demographic characteristics with economic scarcity and poor housing conditions, all associated with disadvantage. This study finds that household vulnerability, as conceptualized herein, is consistently associated with a lower propensity to engage in circular consumption behaviours confirming from another perspective how the CE, as currently shaped, is not inclusive for households.

This study has several limitations. First, due to the lack of comprehensive data, it allows only a partial description of disparities in engagement with specific circular consumption behaviours, such as maintenance and repair. Circular consumption opportunities in the other two stages of consumption, i.e. purchase and end of use (Zibell et al., 2025), could not be investigated within the framework of this study because of data constraints. To address this limitation, either the HBS or other long-standing household surveys could be expanded to include targeted questions related to circular consumption behaviours. Incorporating questions related to reusing, sharing, and recycling would provide valuable insights into household-level circular consumption behaviors and allow to monitor progress toward local, national and EU CE policy objectives. Second, the HBS data does not allow for analysis at local or community level. The results therefore represent national averages, overlooking local specificities, contextual challenges, and enabling factors that could inform more tailored, place-based policy interventions. In fact, many CE measures and initiatives are implemented at local scales (such as the promotion of repair activities, sharing practices, or second-hand markets) and often generate short-term or localized effects. These dynamics are difficult to capture using national statistics that operate at broader temporal and spatial resolutions. Third, the definition of vulnerability adopted in this study is limited to economic, demographic and structural factors and does not account for other important dimensions that contribute to the complex nature of vulnerability. These include disability, migration background, unemployment, level of education (ISTAT, 2020), class, ethnicity (Sovacool et al., 2021c), gender (Sovacool et al., 2021a), tenancy (Sovacool et al., 2021a), type of dwelling (Whetstone et al., 2020). Finally, the social implications of CE transitions extend beyond tangible products, services, and consumption behaviours. Particularly when viewed through the lens of inequality and vulnerability, they also encompass intangible social dimensions, such as social cohesion, the value attributed to community-based and non-profit initiatives, the identity shift from passive consumers to active co-creators through do-it-yourself repair practices, and the collective sense of responsibility involved in actions such as proper waste disposal (Liu, 2025). As these dimensions remain only partially explored, future research should seek deepening understanding through in-depth qualitative methods, including interviews and participatory approaches.

This study provides general insights that can inform the design of future European, national, and local policies and measures aimed at promoting a more inclusive CE. On the one hand, the analysis of vulnerability archetypes highlights the urgent need to foster greater engagement in the CE among the most vulnerable groups, who currently display lower levels of engagement in circular consumption behaviours. On the other hand, the findings concerning the socioeconomic drivers of circular consumption suggest that certain socio-demographic groups already disadvantaged in the socioeconomic contexts of Portugal (e.g., individuals with lower levels of education and income) and Italy (e.g., women, who are less engaged) are also less likely to adopt circular consumption behaviours. This pattern indicates that, to date, the diffusion of CE principles in society has occurred mainly among groups that are not disadvantaged in other aspects of daily life. Consequently, CE policies should be more explicitly directed towards ensuring that the transition does not reproduce existing inequalities, but rather contributes to making circular consumption opportunities more accessible to the socio-demographic groups that are most vulnerable.

From a policy perspective, in recent years, several policy measures have been introduced to tackle the phenomenon of product obsolescence. The EU Right to Repair Directive, adopted in June 2024, extends the legal guarantee period by 12 months when consumers opt for repair, enhances access to spare parts and repair information, and encourages repair over replacement. At the same time, it provides incentives for manufacturers to design products that are more durable, repairable, reusable, and recyclable (European Council). Complementarily, the EU Regulation 2024/1781 establishes a comprehensive framework for eco-design requirements for sustainable products, aiming to enhance their durability, reusability, upgradability, and reparability (European Union). While these measures represent a significant step forward in addressing planned and economic obsolescence, further time and empirical evidence will be needed to assess their actual impact on the diffusion of circular consumption behaviours among European consumers, in different socioeconomic conditions.

Our study has important implications for policy design. It highlights the importance of adopting an equity-focused approach to CE policies and measures. Interventions that disproportionately burden vulnerable households, such as taxes on non-circular goods, risk exacerbating existing inequalities and undermining public support for the CE transition. Instead, policies should aim to empower vulnerable groups by addressing structural barriers, such as affordability and access to digital technologies. Finally, this study contributes to the broader academic discourse on sustainability and social justice. It challenges the notion that circular consumption behaviours are inherently equitable and highlights the need for nuanced analyses that account for socioeconomic heterogeneity. In conclusion, this study underscores the critical role of households, particularly vulnerable groups, in advancing the CE. By examining the socioeconomic determinants of circular consumption and identifying the barriers faced by vulnerable and disadvantaged groups, we provide actionable insights for policymakers and practitioners. Our findings highlight the importance of designing inclusive CE policies that empower all households to contribute to sustainability goals while avoiding unintended consequences. As the CE transition gains momentum, ensuring that no one is left behind will be essential for achieving a just and sustainable future.

## Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work, the author(s) used OpenAI ChatGPT to improve the code for modelling the socioeconomic drivers of circular consumption behaviours and the effect of vulnerability on circular consumption behaviours, as well as to improve the readability and syntax of the manuscript.

## CRediT authorship contribution statement

**Silvia Tomasi:** Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. **Jonathan Cohen:** Conceptualization, Methodology, Validation, Writing – original draft, Writing – review & editing. **Jurgita Bruneckienė:** Validation, Writing – original draft, Writing – review & editing. **Lina Dagilienė:** Validation, Writing – original draft, Writing – review & editing. **Jessica Balest:** Funding acquisition, Project administration, Validation, Writing – original draft, Writing – review & editing. **Chiara Pellegrini:** Project administration, Writing – review & editing. **Leonardo Rosado:** Conceptualization, Funding acquisition, Writing – review & editing. **Nicolas Caballero:** Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Validation, Writing – original draft, Writing – review & editing.

## Declaration of competing interest

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

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## Appendix A

**Table 13**
Circular consumption indicators used in the analysis and the corresponding variables in the HBS national datasets.

| Indicator | Original HBS variables |
|---|---|
| Cleaning, repair, tailoring and hire of **clothing** | d210_mensile, d208_mensile (IT);<br>desp_03142 (PT) |
| Cleaning, repair, and hire of **footwear** | d211_mensile (IT);<br>desp_0322 (PT) |
| Materials for the maintenance and repair of the **dwelling** | B117_bf, B119_bf, B123_bf, B125_bf, B129_bf, B178_bf, B180_bf, C91_bf, C93_bf, C97_bf, C99_bf, C152_bf, C154_bf, D89_bf (IT);<br>desp_04311 (PT) |
| Repair, installation and hire of **furniture, furnishings and loose carpets** | E21_bf, E51_bf (IT);<br>desp_0512 (PT) |
| Repair, hire and sewing services of **household textiles** | E70_bf, E73_bf, d209_mensile (IT);<br>desp_0522 (PT) |
| Repair, installation and hire of **household appliances** | D75_bf, D82_bf, D89_b (IT);<br>desp_0533 (PT) |
| Maintenance and repair of **personal transport equipment** | F213_bf, d202_mensile (IT);<br>desp_0723 (PT) |
| Repair and rental of **information and communication equipment** | D517_bf, D147_bf (IT);<br>desp_0835 (PT) |
| Hire and repair of **equipment for sport, camping and open-air recreation** | D192_bf, D204_bf, F70_bf, F77_bf (IT);<br>desp_0944 (PT) |
| Repair and rental of **glassware, crockery, and other household utensils** | F165_bf + F197_bf (IT);<br>desp_05404 (PT) |
| Rental of **vehicles without a driver** | E154_bf (IT);<br>desp_07244 (PT) |

## Appendix B

**Table 14**
Socioeconomic vulnerability indicators used in to construct vulnerability archetypes and the corresponding variables in the HBS national datasets

| Indicator | Original HBS variables |
|---|---|
| Income | dec_red_ril (IT);<br>RMon_AE_Quintil (PT) |
| Number of adults | c_Ncmp_fatto (IT);<br>ADP_Dim (PT) |
| Age HRP | c_etacalc_1 (IT);<br>GrpEtario (PT) |
| Children | ADP_Tipo2 (PT) |
| Per capita living space | c_Superf (IT);<br>ALOJ_Area (PT) |

## Data availability

The authors do not have permission to share data.

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