

The influence of a hypothetical eco-score on purchase decisions: Empirical evidence on consumer preferences and consumer segments for mobile phones

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ABSTRACT

Multi-level eco-labels, such as an eco-score, combine various environmental product attributes into one overarching label and have the potential to effectively promote sustainable consumption and business practices. This study uses an adaptive choice-based conjoint analysis based on an online survey ($n = 532$) to explore consumer preferences for a hypothetical multi-level eco-score when purchasing mobile phones. In addition, cluster analysis is applied to identify and characterise consumer segments based on preferences for mobile phone attributes, consciousness for sustainable consumption, and social demographics. Findings indicate a linear, positive effect of an eco-score on purchase behaviour. Among the four identified segments, brand and eco shoppers and new and equipment shoppers show strong preferences for higher eco-score levels, suggesting untapped market potential for sustainable mobile phones. Businesses should, therefore, enhance and label environmental product performance, implement segment-specific targeted marketing strategies, and adopt multi-tier distribution systems. Policy makers are encouraged to test the implementation of an eco-score label in the consumer electronics sector. Overall, this study highlights the potential of more holistic sustainability labels to bridge the gap between consumers' attitudes towards sustainability and their actual consumption choices, promoting cleaner and responsible consumption.

1. Introduction

Offering sustainable products and services is a key task for companies on their path to sustainability transformation (Watz and Hallstedt, 2022), which brings both opportunities and challenges. Internally, drivers of sustainable product innovation include competitive advantage, cost reduction, and improved reputation (Dangelico, 2016). Furthermore, the global sustainability market holds significant growth potential (Elkington and Roberts, 2017). For example, the global green technology and sustainability market is forecast to grow at a compound annual growth rate of 21.6 % from 2022, reaching a value of US \$417.4 billion by 2030 (Precedence Research, 2022). In the consumer electronics industry, shifting from a linear to a circular economy is seen as a promising way to addressing resource scarcity and environmental impact (Ellen MacArthur Foundation, 2013; Sinha et al., 2016). Extending the lifespan of mobile phones can also help mitigate CO₂ emissions, primarily by reducing the need for new device production

(Rizos et al., 2019). Accordingly, with recent right-to-repair and eco-design legislation, the European Union (EU) is promoting longer product lifetimes and corresponding business models (e.g. European Parliament and Council, 2024).

However, sustainable product adoption depends on consumers' willingness to buy. Research has shown that while consumers are increasingly aware of the negative social and environmental impacts of conventional business practises and adjust their attitudes accordingly, actual sustainable purchase behaviour lags behind attitudes (e.g. Carlington et al., 2010; Cheah and Aigbogun, 2022; Gruber and Schlegelmilch, 2014; Jacobs et al., 2018). One reason for this discrepancy between attitude and behaviour is that consumers still need support to better understand the sustainability implications of their consumption choices (cf. Torma and Thøgersen, 2021).

For many consumption contexts, product attributes such as brand or performance are readily apparent to consumers. However, the environmental impacts of products are not as visible. Eco-labels can bridge this gap by reducing information asymmetry between consumers and

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Abbreviations

ACBC	Adaptive choice-based conjoint
BYO	Build-your-own
CFA	Confirmatory factor analysis
CSC	Consciousness for sustainable consumption
EU	European Union

producers, and help consumers make more sustainable purchase decisions (e.g. Acharya, 2020; Bieser et al., 2022; Bratt et al., 2011; Nikolaou and Kazantzidis, 2016). Research suggests that eco-label certification not only promotes sales of certified products, but also encourages companies to invest (more) in environmentally friendly product innovation (Oh et al., 2020). Yet, existing eco-labels tend to focus on narrow environmental aspects and are often displayed simultaneously, causing confusion and information overload (Horne, 2009; Monier-Dilhan, 2018; Torma and Thøgersen, 2021). An alternative to such single-issue eco-labels are multi-dimensional and multi-level eco-labels, which cover environmental product performance more holistically and go beyond simple categorical (yes or no) compliance with minimum standards. A systematic literature review on sustainability labelling proposes that such labels make it easier for consumers to understand how well a product performs in terms of sustainability (Torma and Thøgersen, 2021).

Against this background, the possible introduction of an eco-score for different product categories in Europe has been debated (Pistorius and Foote 2021). The effectiveness of an eco-score has been primarily studied in research on sustainable food consumption (e.g. De Bauw et al., 2022a; De Bauw et al., 2022b; De Bauw et al., 2021; Marette, 2022; Weber, 2021). However, in light of the ambitions of the European Green Deal to make sustainable consumption easier (Institute for European Environmental Policy, 2019), research on consumer preferences for an eco-score in product categories other than food is needed.

Similarly to the food sector, the consumer electronics industry is characterised by substantial negative environmental and social impacts. Given their widespread adoption and significant environmental footprint, mobile phones have emerged as a focal point within the industry. The negative environmental effects of mobile phones vary throughout their life cycle and are particularly evident in the extraction of raw materials, manufacturing, energy consumption during use, and waste disposal. These effects are exacerbated by their low reparability and their short replacement cycles of around two years (e.g. Cordella et al., 2021; Ercan et al., 2016; Suckling and Lee, 2015). Social issues include poor working conditions and labour rights violations (TCO Certified, 2014). A transformation of the consumer electronics industry, and the mobile phone sector in particular, is inevitable to achieve sustainable development (Griese et al., 2005). Yet, previous research on multi-level eco-labelling in the context of electrical appliances has primarily focused on specific sustainability aspects. For example, studies have investigated the effectiveness of multi-level labels and scores such as the EU energy efficiency labels for washing machines (Sammer and Wüstenhagen, 2006) and televisions (Heinzle and Wüstenhagen, 2012), as well as a product lifetime label for washing machines (Jacobs and Hörisch, 2022), and a circular economy score for mobile phones and vacuum cleaners (Boyer et al., 2021a; Hunka et al., 2021). Overall, these studies show that multi-level eco-labels covering specific aspects of environmental sustainability positively influence purchase decisions for electrical appliances. At the same time, the studies reveal important research gaps. First, it remains unclear whether the positive influence of a holistic eco-score observed for food products can be replicated in the consumer electronics sector. Given their higher price points, longer usage periods, and greater complexity compared to food items, consumer responses to the eco-score for mobile phones may differ. Second,

knowledge on consumer segments and characteristics influencing sustainable mobile phone purchases is limited (c.f. Boyer et al., 2021b; Wilhelm, 2012), although this could help manufacturers and retailers to target potential sustainable mobile phone customers.

To address these research gaps, this study investigates the following research questions.

1. What are consumers' preferences for a hypothetical eco-score in the context of mobile phone purchases?
2. Can consumer segments with different preference structures be identified based on these preferences? If so, how do their psychographic and sociodemographic profiles differ?

Using an experimental online survey with adaptive choice-based conjoint (ACBC) and cluster analysis, our study examines consumer preferences for a hypothetical multi-level eco-score, along with other sustainable and conventional product attributes, in the context of mobile phone purchases. The study further explores consumer segments in relation to these preferences. By focusing on a holistic, multi-level eco-score label, the study provides first empirical evidence for the effectiveness of an eco-score in the mobile phone context, extending prior research beyond addressing only specific aspects of environmental sustainability. Thus, our study contributes to research on how consumers can be informed about the overall environmental impact of the products they buy by testing a holistic yet simple label. This research is also relevant because it explores whether consumers place significantly greater value on higher degrees of environmental sustainability and whether variations in these levels generate different degrees of utility in consumer electronics purchase decisions. Finally, we identify consumer segments with comparatively strong preferences for an eco-score of mobile phones and provide insights for effective sustainable marketing strategies.

The article is structured as follows: Section 2 reviews the theoretical background and state of research, forming the basis for the hypotheses. Section 3 details the methodology, including ACBC design and sample characteristics. Section 4 presents results, while section 5 discusses the findings and presents the practical implications, study limitations, and future research directions.

2. Theoretical background and hypotheses

2.1. Consumer preferences for a hypothetical eco-score

To address the research questions, Lancaster's (1966) consumer theory is used as a theoretical framework. According to Lancaster (1966), it is not the products as such that provide benefits to consumers, but the product attributes that are important in shaping consumer preferences. Based on these theoretical assumptions, the influence of individual product attributes can be identified, studied and compared with others in purchase decision contexts where many different product attributes simultaneously influence behaviour. Several consumer studies have already investigated consumer preferences for single (hypothetical) sustainable product attributes, including sustainability labels, based on Lancaster's framework (e.g. Jacobs and Hörisch, 2022; Krause and Battenfeld, 2019; Tapsoba et al., 2022).

In the research field of cleaner and responsible consumption and production, there is a growing consensus that a better understanding of consumer behaviour is essential to strengthen sustainable business practises such as sustainable product innovation (cf. Jacobs, 2023; Rabadán and Bernabéu, 2021). The research field focuses, for example, on sustainability labels as a means of promoting sustainable products and services (e.g. Beck and Toulouse, 2023; Jürkenbeck, 2023). In general, the study of the influence of multi-level eco-labels (including hypothetical or not yet existing ones) on purchase behaviour is of current interest (cf. Fresacher and Johnson, 2023; Jacobs and Hörisch, 2022; Jürkenbeck, 2023; Stampa and Zander, 2022; Torma and

Thøgersen, 2023; Williams et al., 2023). Particularly, in research on sustainable food consumption, the debate on the relevance and influence of a multi-level eco-score integrating several ecological product criteria has recently gained momentum (e.g. De Bauw et al., 2022a; De Bauw et al., 2022b; De Bauw et al., 2021; Jürkenbeck, 2023; Marette, 2022; Weber, 2021). Typically, the sustainability performance of a product labelled with an eco-score is rated on a letter-based traffic light scale ranging from 'A' (dark green) to 'B' (green), 'C' (yellow), 'D' (orange) and 'E' (red). The interpretive logic of the 5-level scale is straightforward, i.e. a product with an eco-score of 'A', for example, is considered more sustainable (i.e. with less environmental impact) than the same product with an eco-score of 'C' (cf. De Bauw et al., 2022a; Jürkenbeck, 2023, Pistorius and Foote 2021). Based on experimental research, the eco-score has been shown to help consumers identify ecological food products and thereby promote sustainable food choices (e.g. De Bauw et al., 2022a; Jürkenbeck, 2023; Marette, 2022; Weber, 2021). Interestingly, De Bauw et al. (2022b) show that the eco-score is as important to respondents as price and more important than a certified organic label. At the same time, there are indications that the eco-score might be ineffective when displayed alongside other established sustainability labels (De Bauw et al., 2021).

Despite the great potential for strengthening sustainable consumption in the mobile phone market, there is a lack of research on consumer preferences for a holistic, multi-level eco-score for mobile phones. We argue that findings on the positive impact of an eco-score on purchase decisions in the food context may be transferred to the mobile phone context. This is supported by the limited number of studies that have investigated consumer preferences for sustainable product attributes of mobile phones, indicating that sustainability information positively influences purchase behaviour, e.g. product lifetime information (Van den Berge et al., 2023; Wilhelm, 2012), circular economy score (Boyer et al., 2021a; Hunka et al., 2021), durability (Sata, 2013), and guaranteed software updates and improved performance (Mugge et al., 2017). Therefore, we formulate our first hypothesis as follows.

H1. Higher levels of a hypothetical eco-score have a positive influence on the purchase of mobile phones.

Specifying the shape of the influence of the eco-score by determining how consumers respond to the different levels would provide valuable insights in how to promote effective sustainability management and labelling schemes. In this sense, research on the impact of multi-level eco-labels and environmental product information in the context of electrical appliances can provide initial indications. Studies by Sammer and Wüstenhagen (2006) and Sonnenberg et al. (2014) show a linear increase in the utility consumers derive from an improvement in the energy efficiency classes of washing machines. It follows that energy efficiency remains constantly important for consumers regardless of the actual level. However, Jacobs and Hörisch (2022) find that the positive effect of product lifetime labelling on the purchase decision for washing machines decreases with higher levels of product lifetime. This supports the study by Wilhelm (2012) in the context of mobile phones, which also points to a decreasing positive effect of product lifetime information on consumer preferences. Jacobs and Hörisch (2022) argue that a very long product lifetime, as opposed to high energy efficiency, can also be associated with disadvantages for consumers, such as outdated performance, energy efficiency or design of the product. When investigating the influence of a circular economy score (referring to the level of reuse and refurbishment) on consumer demand for mobile phones, Hunka et al. (2021) even find the so-called Goldilocks effect on respondents' utility, i.e. medium levels of the circular economy score are considered optimal by respondents. Hunka et al. (2021) point out that high levels of reuse and refurbishment can conflict with consumers' desire for a product to look and function like new. Overall, different to product longevity and circularity, but similar to energy efficiency, we assume that consumers do not associate disadvantages with a strong overall environmental product performance, which translates into high levels of

an eco-score. Therefore, we assume a linear effect of the eco-score and formulate the hypothesis as follows.

H2. The positive effect of a higher hypothetical eco-score on the purchase of mobile phones increases approximately linearly such that each improvement in the eco-score yields a similar increase in consumer preference.

2.2. Consumer segments for (sustainable) mobile phones

Identifying and characterising consumer segments that differ in their preferences for sustainable mobile phones is extremely important for practitioners to unlock the market potential for sustainable products. However, there are only a few segmentation studies in the mobile phone context that consider sustainable product attributes (Boyer et al., 2021b; Mugge et al., 2017; Wallner et al., 2022). Overall, they suggest that consumers show different preferences for the sustainability performance of mobile phones in their purchase decisions. Based on cluster analysis, all aforementioned segmentation studies have identified at least one sustainability-sensitive consumer segment. While consumers overall prefer conventional mobile phones to refurbished mobile phones because they are more familiar with the former and consider them more reliable, some consumers value the environmental and innovative qualities of refurbished mobile phones (Gehin et al., 2008; Mugge et al., 2017; Van Weelden et al., 2016). Consequently, Mugge et al. (2017) identified six distinct customer segments, including three clusters (representing 46 % of the sample) that appear to have the greatest potential to purchase refurbished mobile phones. Similarly, Boyer et al. (2021b) found four distinct customer segments for mobile phones, including two groups with a strong preference for circular economy, referred to as 'circular enthusiasts' and 'price sensitive, open to circular economy'. However, the focus of previous segmentation research was limited to specific aspects of a product's environmental sustainability, such as refurbishment (Mugge et al., 2017; Wallner et al., 2022) or circularity (Boyer et al., 2021b). None of the segmentation studies considers preferences for the overall environmental impact of a mobile phone, expressed for example by an eco-score. Such an aggregated measure may elicit different consumer preferences than specific environmental attributes alone, and could play a central role in shaping consumer segments.

Based on these previous findings, we want to support that segmentation into at least two consumer segments is possible, and we also hypothesise that the eco-score plays a particular role in this. Therefore, the hypotheses are formulated as follows.

H3. Consumer segments with different preference structures regarding the purchase of mobile phones, which also have sustainable attributes, can be identified.

H4. Consumers' preference for a hypothetical eco-score contributes to the separation of consumer segments.

Standard marketing management and consumer segmentation literature (e.g. Kotler and Keller, 2021; Wedel and Kamakura, 2000) and previous research on characterising sustainable consumers (e.g. Diamantopoulos et al., 2003; Krause and Battenfeld, 2019; Verain et al., 2012) have highlighted the need to examine not only sociodemographic but also behavioural and/or psychographic consumer characteristics. Similarly, previous research reveals that a sustainable lifestyle is an important factor in explaining the involvement with sustainable mobile phones (Haucke, 2018). Mugge et al. (2017) suggest that some consumers may be guided by the environmental benefits of refurbished mobile phones due to their environmental consciousness. In addition, research indicates that sustainability information such as an eco-label is effective (only) when consumers are environmentally concerned (e.g. Grankvist et al., 2004; Petersen et al., 2021). To better explain sustainable consumption behaviour, Balderjahn et al. (2013) developed a psychometric measure that incorporates all dimensions of sustainability (environmental, social, and economic), the consciousness for

sustainable consumption (CSC) scale. Since then, several empirical studies have shown that consumers' CSC – considering environmental, social, and economic aspects of consumption – significantly affects various types of sustainable consumption behaviours (e.g. Balderjahn et al., 2013; Balderjahn and Hüttel, 2019; Hüttel et al., 2018).

While research in the banking, food or clothing context shows that sustainable consumers often differ from conventional consumers in terms of social demographics (e.g. Krause and Battenfeld, 2019; Park and Lin, 2020; Verain et al., 2012), few studies examine the role of sociodemographic characteristics in explaining sustainable mobile phone consumption. For example, a review of the sociodemographic differences between customer groups identified in the study by Mugge et al. (2017) shows that one of the three pro-refurbishment clusters has a significantly higher proportion of women and that the cluster least interested in refurbished mobile phones is significantly older than the sample average.

Boyer et al. (2021b) found no sociodemographic differences in consumer preferences for circular mobile phones, possibly due to methodological limitations.

Therefore, we hypothesise that CSC and sociodemographic factors are useful and complementary variables to characterise consumer segments in the context of sustainable mobile phones. CSC provides a comprehensive psychographic measure and has shown strong predictive power in sustainable consumption research (e.g. Balderjahn et al., 2013; Balderjahn and Hüttel, 2019). Sociodemographic characteristics such as gender, age and education, although limited in predictive strength in isolation, are standard variables used in segmentation research and offer practical value – especially when combined with psychographic constructs like CSC (cf. Kotler and Keller, 2021; Verain et al., 2012). The hypotheses are formulated as follows.

H5. Different types of consumers' CSC serve as differentiators between consumer segments.

H6. Sociodemographic characteristics serve as differentiators between consumer segments.

3. Methods

3.1. Adaptive choice-based conjoint analysis

3.1.1. General remarks

When the products or product attributes of interest are hypothetical in nature or not yet introduced, such as an eco-score for mobile phones, stated preference methods such as conjoint analysis provide an appropriate way to identify consumer preferences (cf. Hunka et al., 2021; Jacobs and Hörsch, 2022). Conjoint analysis represents a set of multivariate methods that are well suited to estimate the structure of stated consumer preferences for different attribute levels of product alternatives (Rao, 2014). Conjoint methods build on Lancaster's (1966) consumer theory as a theoretical framework. This study uses ACBC analysis, a newer approach to conjoint analysis that tends to delve deeper into respondents' decision-making structures and provides more accurate and predictive utility estimates than traditional choice-based conjoint analysis. ACBC questionnaires test a wide range of product profiles (i.e. combinations of product attributes) but focus on a subset that is of most interest to the respondent. This reduces the risk of unattractive profiles being displayed to the respondent (Sawtooth Software, 2014). ACBC research designs have been used in marketing research on a variety of topics and more recently to investigate consumer preferences for sustainable attributes of electrical appliances (e.g. Boyer et al., 2021a; Hunka et al., 2021). However, its application to evaluate an eco-score and sustainability trade-offs in consumer electronics is novel. Our study is among the first to examine a holistic eco-score in conjunction with specific sustainability attributes in the mobile phone sector. Technical details on ACBC analysis can be found in Chapman et al. (2009), Johnson and Orme (2007) and Sawtooth Software (2014).



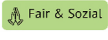




3.1.2. Design of the questionnaire

The online survey comprised an ACBC questionnaire developed using Sawtooth Software's Lighthouse Studio software. The context of the questionnaire was the online purchase of mobile phones through an unbranded internet search engine. As is typical of ACBC designs, the questionnaire included the following three core phases: Build-your-own (BYO) configurator, screening phase and choice tasks. First, in the BYO phase, respondents were asked to assemble their ideal mobile phone profile from a set of pre-selected product attributes (brand, equipment version) and levels. Based on the responses from the BYO phase, the following screening section presented successively different groups of 'near-neighbour' profiles, i.e. the attribute values displayed were relatively concentrated on the respondent's preferred attribute levels but still included the full range of levels. Respondents were asked whether they would consider buying these profiles and whether certain attribute levels were unacceptable or 'a must' for them. In the choice task phase, respondents were each shown three surviving mobile phone profiles (i.e. profiles that had been marked as possibilities in the previous section) in several consecutive tasks, from which they had to choose one profile. Finally, an optional calibration section was added in which respondents were asked to rate their likelihood of purchasing different mobile phone profiles. The calibration section was used to estimate a utility threshold for the none-option (cf. Sawtooth Software, 2014).

ACBC research designs are commonly used with a high number of product attributes and levels (cf. Sawtooth Software, 2014). The generation of market-relevant attributes and levels for this study was done in three steps: (i) a search for product offerings with the search query 'smartphone' in internet search engines such as Google and Ecosia and on marketplaces such as Amazon, Idealo, and Mediamarkt; (ii) a literature review on mobile phone attributes and levels with a focus on conjoint studies (e.g. Hunka et al., 2021; Rahman and Sultana, 2022; Sata, 2013; Wilhelm, 2012); and (iii) a qualitative pre-test using thinking aloud protocols. The selection of product attributes and levels was based on the following criteria. First, the attributes and levels should be relevant to mobile phone buyers in their purchase decisions. Second, they can be displayed in internet search engines, online shops or marketplaces. Third, they can be implemented by mobile phone manufacturers and/or policy makers. In general, it is recommended not to exceed twelve attributes and seven levels per attribute within an ACBC study (Sawtooth Software, 2014). As shown in Table 1, ten mobile phone attributes with two to seven levels and the brand attribute with sixteen levels (including two sustainable brands and fourteen conventional brands according to their popularity, cf. Statista, 2022) were used in the ACBC questionnaire. We limited the number of brands displayed to a maximum of four per respondent, namely the favourite brand selected in the BYO stage, one of the sustainable brands (Fairphone or Shiftphone) and two other brands randomly selected from the remaining fourteen brands. While the eco-score was designed as a colour-coded, multi-level scale, additional sustainable attributes were designed as product tags ('durable', 'fair and social' and 'CO₂ compensation'), which are binary in nature. The condition attribute also reflects sustainability, particularly circular economy, by distinguishing new or used phones. The eco-score was presented to respondents with a brief explanation that it aggregates environmental criteria into a scale from A (dark green) to C (yellow) to E (red) to compare the environmental sustainability performance of products (see Table 1 for details).

In contrast to non-adaptive choice-based conjoint studies, ACBC studies create customised, near-orthogonal experimental designs for

Table 1
Attributes and attribute levels of mobile phones in the adaptive choice-based conjoint analysis.

Attribute	Attribute level	Visual representation in experiment	Additional description for respondents in experiment
Price	€99		
	€199		
	€349		
	€499		
	€649		
	€799		
	€999		
Brand	Samsung		
	Apple		
	Huawei		
	Xiaomi/ Mi		
	Google		
	LG		
	Nokia		
	Sony		
	Honor		
	HTC		
	Motorola		
	OnePlus		
	OPPO		
	ZTE		
Equipment version	Upper class		Powerful smartphone with up-to-date technology, high-end processor, excellent display and top camera equipment, and strong performance.
	Middle class		Averagely equipped device with good camera technology, good display, good processor, good performance and price-performance ratio.
	Basic		Everyday device with compromises in camera and technology, i.e. standard display, sufficient performance, and good photos in daylight.
Shipping costs	Free shipping		
	Shipping starting at €4.9		
Shipping time	Same working day		
	1–2 working days		
	3–5 working days		
Customer reviews	5 stars	★★★★★	Customer reviews stem from consumers who have already had experience with a product. Customer reviews serve as a decision-making aid before purchase and indicate whether other buyers' expectations have been met.
	4 stars	★★★★☆	
	3 stars	★★★☆☆	
Condition	New		
	B-stock		Returned item/display item with signs of use.
	Refurbished		Returned item that has been checked for faults, malfunctions, and visual defects; and that had been repaired if necessary. Items of this type are also referred to as refurbished and are resold with a warranty.
CO ₂ compensation	Yes		Products cause greenhouse gases such as CO ₂ emissions. A green tree indicates whether part of the purchase price is invested in tree planting projects and thus in climate protection. The costs are thus included in the purchase price.
	No		
Product longevity	'durable'		Products marked with 'durable' are characterised by robust materials and product durability.
	No information		
Fair production and trade	'fair and social'		Products marked with 'fair and social' are characterised by socially responsible production conditions and fair trade.
	No information		
Eco-score	A		The eco-score allows comparing the sustainability performance of products within a product group. Environmental criteria are aggregated and assigned to the scale from A (dark green) to C (yellow) to E (red). For example, a product with a dark green A is the more environmentally friendly choice compared to a product with a yellow C.
	B		
	C		
	D		
	E		

each respondent on the fly (Sawtooth Software, 2014). As a result of the qualitative pre-test, prohibitions were predefined to exclude implausible attribute level constellations from the questionnaire.¹ In addition, we visually represented some attributes such as the eco-score to increase the perception of reality and elicit marketplace-like reactions from participants (cf. Hauser et al., 2019).

Appendix S1 shows the introductory text and an example choice task of the ACBC questionnaire. Empirical evidence suggests that highlighting the potential practical consequences of the survey in the survey script improves respondent behaviour (Interis and Petrolia, 2014; Lewis et al., 2016; Zawojka et al., 2019). Therefore, we informed respondents in the survey introduction that their answers would help improve the results displayed in the shopping function of an internet search engine. As part of the introduction, we also included a reminder about the budget (cf. Gschwandtner and Burton, 2020) and briefly described how the ACBC questionnaire works with its four phases.

3.2. Survey measures

In addition to the ACBC questionnaire, the online survey included questions on social demographics (i.e. gender, age, highest educational achievement and net monthly household income) and CSC. To measure respondents' CSC, we used the 12-item short scale on CSC, which comprehensively captures the environmental, social and economic dimensions of CSC and has high reliability and validity (Balderjahn et al., 2013; Balderjahn and Hüttel, 2019; Buerke, 2016; Ziesemer et al., 2016). The items were formulated on the basis of Ziesemer's et al. (2016) version of the CSC scale and measured on 7-point Likert scales from 'does not apply at all' to 'fully applies'.

To assess the validity and reliability of the CSC scale, we conducted a confirmatory factor analysis (CFA). In addition to the descriptive statistics, see Appendix S2 for the CFA results showing substantial factor loadings and reasonable reliabilities with respect to widely recommended cut-off values (≥ 0.7 for factor loadings; ≥ 0.7 for α and ω ; ≥ 0.5 for AVE; e.g. Fornell and Larcker, 1981; Nunnally and Bernstein, 1994; Shevlin and Miles, 1998) for each of the five CSC subscales. We can also assume discriminant validity between all constructs, with one exception. Following the well-established Fornell-Larcker criterion (Fornell and Larcker, 1981), we find that only the pair of consciousness for environmental consumption and consciousness for social consumption narrowly misses this criterion (squared correlation = 0.815, AVE CSC-EN = 0.790, AVE CSC-SO = 0.776). The CFA model also fits the data well ($\chi^2/df = 105.815/55 = 1.924$; robust CFI = 0.984; robust TLI = 0.977; robust RMSEA = 0.049, 90 % confidence interval of [0.035; 0.063]; SRMR = 0.032; e.g. Hair Jr. et al., 2013; Hu and Bentler, 1999; Kline, 2016).

3.3. Data collection and sample characteristics

The online survey was conducted in May 2022 via the market research institute Innofact using a large ISO-certified online access panel. Participants in this study were expected to shop several times a year in online shops such as Amazon, Ebay or Zalando; and to use internet search engines such as Google, Bing, Ecosia or DuckDuckGo on a weekly basis. In addition, we only selected participants who indicated that they would buy a mobile phone within the next two years (e.g. due to a contract renewal). In terms of data quality, respondents who completed the survey in less than 40 % of the median survey time

¹ The prohibitions used are as follows: Brand Fairphone with eco-score C or worse, brand Shiftphone with eco-score C or worse, 'durable' tag (product longevity) with eco-score C or worse, 'fair and social' tag (fair production and trade) with eco-score C or worse, equipment version basic with the price levels €799 or €999, equipment version middle class with price levels €99 or €999, and equipment version upper class with price levels €99 or €199.

(speeders) and respondents who only entered wild letter combinations or similar in open text field questions were removed from the dataset. The final sample includes 534 respondents.

Quota sampling was used to ensure representativeness of the population. Sociodemographic quotas were applied for gender, age, highest educational achievement and monthly household net income. A comparison of the sociodemographic composition of the sample with the quotas and the German adult population is presented in Appendix S3. While the sample is representative in terms of gender and age, we find that people with higher educational qualifications are underrepresented in the sample and people with lower educational qualifications are overrepresented. Therefore, we describe the sample as nearly representative of the German adult population. The ACBC-related data collection and analysis procedures were carried out using Lighthouse Studio (version 9.14.0) from Sawtooth Software. All other statistical analyses were performed with R (version 4.2.1).

4. Analysis and results

4.1. Influence of a hypothetical eco-score on purchase decisions

Table 2 shows the average utility values of the individual attribute levels resulting from the utility modelling of the ACBC analysis based on hierarchical Bayes estimation. It also shows whether the increase in utility from one level to the next more preferred level is statistically significant. Hierarchical Bayes utility modelling is considered the most advanced approach for analysing choice-based conjoint data because it accounts for the heterogeneity of respondents' preferences by estimating utility at the individual level (e.g. Orme and Chrzan, 2021; Rossi and Allenby, 2003). The average root likelihood value of 0.758 indicates a good fit of the ACBC utility model (cf. Orme, 2013).

The utilities of all mobile phone attributes are derived from piecewise linear part-worth functions (cf. Rao, 2014). With the exception of some individual estimates for price, brand, equipment version and shipping time, all average utility estimates shown in Table 2 appear immediately plausible in terms of the preference order. However, a price of €199 is preferred over a price of €99. This could be due to the fact that €99 may signal a very weak product performance. This argument is strengthened by the fact that €99 was only shown in combination with the basic equipment version. Furthermore, it is noticeable that the two sustainable brands (Fairphone and Shiftphone) are very high up in the preference order. This may be because we limited the number of brands displayed to a maximum of four per respondent, with one of them definitely being one of the sustainable brands (see section '3.1 Adaptive choice-based conjoint analysis'). This experimental design decision was made deliberately in order to obtain sufficient preference data for the sustainable brands; while it may have led to an overestimation of the utility of these brands. We also find that the upper class equipment version generates less utility for the respondents than the middle class version. This could be because 'upper class' tends to be displayed with higher prices than 'middle class'. In addition, mid-range mobile phones may be seen as sufficiently powerful for everyday use, so that high-end mobile phones are unlikely to offer the average consumer much added technical value these days. Shipping time generally shows a low utility range and no significant utility increases from one level to the next, indicating a low influence of the attribute on the purchase of mobile phones.

In terms of price, equipment version, shipping costs, customer reviews, CO₂ compensation, product longevity, fair production and trade, and eco-score, all utility increases from one level to the next prove to be significant. However, there is no significant increase in utility when the condition of the mobile phone improves from refurbished to b-stock, i.e. respondents do not seem to make a difference between these two options. In terms of conventional brands, there was no predetermined order of preference. It turns out that there are several groups of conventional brands that are almost equally preferred by respondents, and

Table 2
Hierarchical Bayes utility modelling results of the adaptive choice-based conjoint analysis, and significance tests.

Attribute level	Model of the adaptive choice-based conjoint analysis (n = 534)			
	Average utility ^{a,b}	SD	95 % CI	p value ^c
Price				
€199	116.90	110.28	[107.52; 126.27]	***
€99	97.73	133.89	[86.35; 109.12]	***
€349	76.72	64.78	[71.21; 82.23]	***
€499	33.55	40.60	[30.10; 37.00]	***
€649	-46.23	68.16	[-52.02; -40.43]	***
€799	-105.79	93.33	[-113.72; -97.85]	***
€999	-172.89	128.56	[-183.81; -161.96]	n/a
Brand				
Samsung	142.15	72.53	[135.99; 148.32]	***
Fairphone	80.73	34.09	[77.83; 83.63]	***
Shiftphone	70.87	25.19	[68.72; 73.01]	***
Apple	66.68	147.19	[54.17; 79.20]	***
Sony	-3.86	52.07	[-8.29; 0.56]	***
Huawei	-3.88	74.15	[-10.18; 2.43]	***
Xiaomi/ Mi	-4.09	68.12	[-9.88; 1.70]	***
OPPO	-24.66	33.43	[-27.50; -21.82]	***
LG	-27.86	50.92	[-32.19; -23.54]	***
Google	-27.90	68.50	[-33.72; -22.08]	***
ZTE	-30.18	33.71	[-33.05; -27.32]	***
Motorola	-31.35	40.85	[-34.82; -27.88]	***
Honor	-40.50	40.55	[-43.95; -37.05]	***
OnePlus	-42.65	47.40	[-46.68; -38.62]	***
HTC	-44.50	39.66	[-47.87; -41.13]	***
Nokia	-46.31	59.38	[-51.35; -41.26]	n/a
Equipment version				
Middle class	28.77	31.20	[26.11; 31.42]	*
Upper class	20.57	55.89	[15.81; 25.32]	***
Basic	-49.33	43.72	[-53.05; -45.61]	n/a
Shipping costs				
Free shipping	3.71	10.54	[2.82; 4.61]	***
Shipping starting at €4.9	-3.71	10.54	[-4.61; -2.82]	n/a
Shipping time				
3–5 working days	1.42	12.58	[0.35; 2.49]	***
Same working day	-0.02	13.26	[-1.14; 1.11]	***
1–2 working days	-1.40	11.55	[-2.38; -0.42]	n/a
Customer reviews				
5 stars	6.37	17.70	[4.86; 7.87]	**
4 stars	3.44	13.99	[2.25; 4.63]	***
3 stars	-9.81	19.03	[-11.42; -8.19]	n/a
Condition				
New	50.70	55.16	[46.01; 55.39]	***
B-stock	-24.41	35.83	[-27.46; -21.37]	***
Refurbished	-26.29	39.59	[-29.65; -22.92]	n/a
CO₂ compensation				
Yes	5.02	12.79	[3.93; 6.10]	***
No	-5.02	12.79	[-6.10; -3.93]	n/a
Product longevity				
'durable'	4.51	13.20	[3.39; 5.64]	***
No information	-4.51	13.20	[-5.64; -3.39]	n/a
Fair production and trade				
'fair and social'	6.08	13.64	[4.92; 7.24]	***
No information	-6.08	13.64	[-7.24; -4.92]	n/a
Eco-score				
A	24.20	30.66	[21.60; 26.81]	***
B	13.60	21.21	[11.80; 15.40]	***
C	-3.82	16.76	[-5.24; -2.40]	***
D	-11.83	28.06	[-14.21; -9.44]	***
E	-22.15	28.02	[-24.53; -19.77]	n/a
None option	307.27	103.83	[298.44; 316.09]	***
Average ^d root likelihood	0.758	0.066		

^a Averaged across all respondents.

^b Based on Hierarchical Bayes estimation (Monte Carlo Markov Chain algorithm, 30.000 iterations prior and 20.000 iterations post convergence, utility estimates averaged per respondent to generate point estimates for each attribute level (e.g. [Howell, 2009](#); [Sawtooth Software, 2022](#))) with standard deviations and 95 % confidence intervals; attributes scaled as zero-centred differences.

^c Utility increases from one level to the next more preferred level based on paired t-tests; significance level: +p ≤ 0.10, *p ≤ 0.05, **p ≤ 0.01, ***p ≤ 0.001.

that Samsung is by far the most preferred conventional brand, followed by Apple. Furthermore, there is no significant difference in utility between both sustainable brands (Fairphone and Shiftphone). Overall, since there is at least one significant utility difference per attribute, it can be testified that all attributes significantly influence the decision to buy a mobile phone.² Considering the significant influence of the hypothetical eco-score as well as the increasing utility for higher levels of the eco-score (i.e. all utility gains from E to A are significant), hypothesis 1 can be supported.

In addition, the average utilities from [Table 2](#) are visualised in [Fig. 1](#). [Fig. 1](#) shows that the hypothetical eco-score has not only a positive but also a roughly linear effect on the purchase of mobile phones. For example, the utility gain from improving the eco-score from level E to D is similar to the utility gain from B to A. This observation was verified by comparing the ACBC model with a nested model, which differed only in that the eco-score entered the utility estimation as a linearly coded attribute rather than a dummy-coded attribute. A likelihood ratio test shows that the original model does not have a significantly better fit than the simpler model ($-2\Delta LL = 0.01$, $\chi^2 = 0.07$, $df = 3$, $p < 0.995$). This supports the approximate linearity of the positive effect of the hypothetical eco-score on purchase decisions in the original model and thus supports hypothesis 2.

[Table 3](#) gives an overview of the average relative importances of the individual mobile phone attributes in the ACBC analysis. The results illustrate the comparatively strong influence of price and brand on the purchase decision. Price (32.8 %) is the most important attribute for respondents, followed shortly by brand (26.6 %). Both are about three times as important as the equipment version (11.2 %) and condition (9.9 %). The hypothetical eco-score (6.4 %) is more important than all other sustainability tags, namely fair production and fair trade (2.1 %), product longevity (2.0 %) and CO₂ compensation (1.9 %). Individually, the latter three as well as customer reviews (3.2 %), shipping time (2.3 %) and shipping costs (1.5 %) seem to play only a minor role in the purchase of mobile phones. The eco-score and all sustainability tags together result in a relative importance of 12.45 % and thus have a similar weight as equipment version and condition.

4.2. Identification and characterisation of consumer segments

We also conducted a cluster analysis to gain insights into potential consumer segments. To determine the optimal number of clusters, we used the widely accepted elbow criterion. After plotting the within-groups sum of squares against the number of clusters, we looked for a bend, i.e. an elbow, in the plot that indicates the optimal number of clusters (cf. [Backhaus et al., 2018](#); [Everitt and Hothorn, 2011](#)). Accordingly, a number of four clusters was determined to be optimal for this study. In addition, we used the relative importances of all eleven mobile phone attributes as cluster variables. From a methodological perspective, the use of robust psychographic measures, such as preferences elicited via experimental surveys, proves highly effective for segmentation and clustering (cf. [Rao, 2014](#)). [Table 4](#) shows the results of the cluster analysis including the psychographic and sociodemographic characterisation of each cluster. Four different consumer segments could be identified, including one sustainability-sensitive segment, so that hypothesis 3 can be supported.

Furthermore, the results show how large the different consumer segments are and – based on t-values and t-tests – for which mobile phone attributes there are particularly strong consumer preferences

² For shipping time, an additional significance test showed that at least the difference between the levels '3–5 working days' and '1–2 working days' is significant.

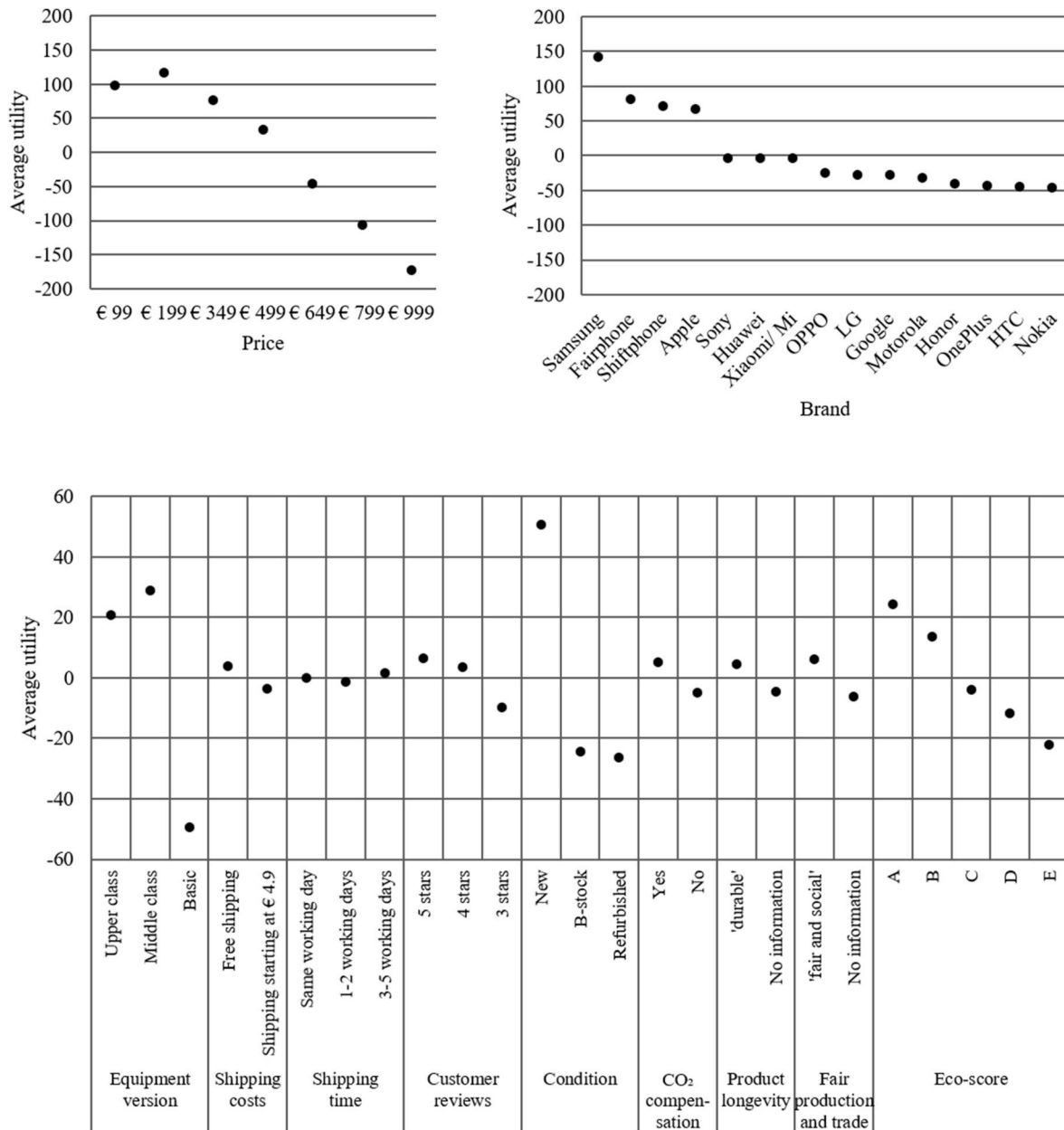


Fig. 1. Visualisation of the utility modelling results.

compared to the survey population. Accordingly, names were assigned to the different consumer segments: 'price shopper' (36.9%), 'brand and eco shopper' (20.0%), 'new and equipment shopper'³ (18.2%) and 'average shopper' (24.9%). The brand and eco shopper segment reveals the strongest values for all sustainability tags and the eco-score (CO₂ compensation = 2.6%, product longevity = 2.5%, fair production and trade = 2.7%, eco-score = 9.4%). The new and equipment shoppers also show above-average preferences for the eco-score (7.6%), while the largest segment of the price shoppers assigns it a below-average relative importance (4.1%). Based on the one-way analysis of variance, each cluster variable, including the relative importance consumers assign to a hypothetical eco-score, contributes significantly to the separation of

consumer segments. Hypothesis 4 can thus be supported. With regard to the circular economy aspect, it should also be noted that price shoppers and brand and eco shoppers attach below-average relative importance to the condition of mobile phones or, in other words, are most open to used phones.

Table 4 also shows how the psychographic and sociodemographic characteristics of consumers differ between the consumer segments and the survey population and how they can be used to further describe the segments. It can be seen that, with the exception of consciousness for debt-free consumption, all types of CSC contribute significantly to differentiating at least one consumer segment from the survey population, which supports hypothesis 5. Consciousness for simple consumption is significantly stronger in the price shopper segment than in the survey population. The average brand and eco shopper shows a significantly stronger consciousness for environmental and collaborative consumption than the average respondent. The new and equipment shopper segment is characterised by significantly lower consciousness for social and collaborative consumption than the average respondent.

³ As in the survey population, respondents of cluster 3 on average gain highest utility regarding the condition attribute from the level 'new'. In contrast to the survey population, they gain highest utility regarding the equipment version attribute from the level 'upper class'.

Table 3
Relative importances of attributes of the adaptive choice-based conjoint analysis.

Attribute	Average relative importance ^a in % (n = 534)	SD
Price	32.80	15.51
Brand	26.64	8.09
Equipment version	11.17	4.96
Shipping costs	1.54	1.32
Shipping time	2.27	1.39
Customer reviews	3.24	2.19
Condition	9.90	6.51
CO ₂ compensation	1.94	1.58
Product longevity	2.00	1.56
Fair production and trade	2.14	1.67
Eco-score	6.37	3.88
Totals	100.00	

^a Averaged across all respondents with standard deviations; a relative importance reflects the range of an individual's utilities for an attribute as a percentage of the corresponding total over all attributes (Orme and Chrzan, 2021).

The average shopper segment shows no significant differences in terms of CSC.

Chi-square tests were conducted to look for significant differences in the categorical sociodemographic variables by testing the sociodemographic distribution of the clusters for homogeneity with the distribution of the survey population. As shown in Table 4, the results of the chi-square tests show three significant results, so hypothesis 6 can be supported. The price shopper segment is significantly older, and the brand and eco shopper segment is significantly younger, than the survey population. In addition, the average brand and eco shopper is significantly higher educated than the average respondent.

Table 5 shows the results of an additional analysis of psychographic and sociodemographic differences between consumer segments based on a multinomial logistic regression analysis, which is particularly useful for analysing group differences (Backhaus et al., 2018). In contrast to Table 4, this characterisation is based on the average shopper segment as the reference cluster rather than the survey population. The results of the regression analysis support some of the key findings, showing that brand and eco shoppers have a significantly stronger consciousness for environmental consumption and that new and equipment shoppers have a significantly lower consciousness for collaborative consumption than the average shoppers. Furthermore, price shoppers are significantly older – and brand and eco shoppers are significantly younger – than the average shoppers.

5. Discussion and conclusion

5.1. Overall results and discussion against previous literature

Our study investigates how a hypothetical multi-level eco-score influences consumer preferences when purchasing mobile phones, and whether consumer segments can be differentiated on this basis. By using ACBC and cluster analysis, this study contributes to previous research in four important ways:

First, many publications on eco-labelling have explored consumer responses to single-issue product certifications, the drawbacks of which are increasingly discussed (e.g. Monier-Dilhan, 2018; Torma and Thøgersen, 2021). By testing an eco-score designed to reflect the overall environmental sustainability of a product through a rating scale, this study adds to the promising but still limited literature on holistic, multi-level sustainability labels (cf. Torma and Thøgersen, 2021). It also contributes to the strong research interest in testing new sustainability labels (cf. Fresacher and Johnson, 2023; Jacobs and Hörisch, 2022; Torma and Thøgersen, 2023).

Second, to the best of our knowledge, our study provides the first empirical evidence of a positive impact of a multi-level eco-score on

consumers' mobile phone preferences, indicating its potential to support more sustainable purchase decisions. While prior research has examined eco-scores in the food sector (e.g., De Bauw et al., 2022b; Jürkenbeck, 2023; Marette, 2022), we did not find empirical studies applying a comparable approach in the context of mobile phones. Therefore, initial findings on a positive effect of the eco-score in the food sector (e.g. De Bauw et al., 2022b; Jürkenbeck, 2023; Marette, 2022) can be transferred to the consumer electronics sector. Similar to previous studies within the electrical appliance sector (e.g. Rahman and Sultana, 2022; Sammer and Wüstenhagen, 2006; Wilhelm, 2012), our results show that the conventional product attributes of price and brand are most important when purchasing mobile phones, followed by equipment version and condition. The eco-score ranks fifth and proves to be more important than all other product tags covering only specific sustainability attributes.⁴ More precisely, the positive effect of the eco-score is found to be approximately linear. This is similar to studies on the multi-level energy efficiency label (cf. Sammer and Wüstenhagen, 2006; Sonnenberg et al., 2014) but contrasts with studies on multi-level product lifetime information/ labelling (cf. Jacobs and Hörisch, 2022; Wilhelm, 2012) and on a multi-level circular economy score (cf. Hunka et al., 2021), which show degressive and inverse-U-shaped effects on consumer preferences. Thus, in contrast to a long product life or a high degree of reuse and refurbishment, a high eco-score level may only reflect benefits for consumers.

Third, the study shows that there are two consumer segments (brand and eco shoppers, new and equipment shoppers) that have comparatively strong preferences for higher eco-score levels in the context of mobile phone purchases. In both segments, price plays a comparatively minor role – similar to the 'sustainability enthusiasts' and 'circular enthusiasts' identified by Mugge et al. (2017) and Boyer et al. (2021b). Across all segments, brand and eco shoppers assign the highest relative importance (9.4 %) to the eco-score. Previous studies have shown that consumers who know and trust eco-labels are more likely to purchase certified products (e.g. Steiner et al., 2017; Zander et al., 2015). However, these studies focus primarily on self-reported trust and label recognition. In contrast, our study uses ACBC analysis to estimate the influence of a holistic eco-score on purchase decisions across different shopper segments in the mobile phone market. While the few segmentation studies related to sustainable mobile phones focus on specific aspects of environmental sustainability such as reuse, refurbishment or reparability (Boyer et al., 2021b; Mugge et al., 2017; Wallner et al., 2022), this is the first segmentation study to investigate consumer preferences for the overall environmental impact of a mobile phone.

Fourth, our results on the characterisation of consumer segments offer new insights into consumer behaviour and marketing related to sustainable mobile phones. Consumers of the brand and eco shopper segment have an above-average consciousness for environmental and collaborative consumption, which supports literature showing a positive influence of both types of CSC on environmental consumption behaviour (cf. Balderjahn and Hüttel, 2019). This finding also supports preliminary evidence that environmental consciousness and lifestyles promote sustainable consumption in the mobile phone industry (cf. Haucke, 2018; Mugge et al., 2017). Brand and eco shoppers' strong consciousness for collaborative consumption fits with the finding that they place little importance on the mobile phone being new (low relative importance for condition). While it may seem intuitive that consumers who value sustainability also place higher importance on the eco-score and score highly on environmental and collaborative consumption consciousness, our study provides empirical evidence for this connection specifically in the mobile phone market – a context that remains under-researched

⁴ The low number of levels (yes/no) of the product tag attributes and the fact that they are not official labels may contribute to their low relevance. The product longevity tag, for example, is not comparable with an official product lifetime label as tested by Jacobs and Hörisch (2022).

Table 4
Cluster analysis results including the psychographic and sociodemographic characterisation of the clusters.

	Cluster (n = 534) ^a								Survey population (n = 534)
	1 'Price shopper'		2 'Brand and eco shopper'		3 'New and equipment shopper'		4 'Average shopper'		
Cluster size	36.9 %		20.0 %		18.2 %		24.9 %		
<i>Cluster variable:</i>	%	t-value ^b	%	t-value ^b	%	t-value ^b	%	t-value ^b	%
Relative importance	100.0		100.0		100.0		100.0		100
Price	49.8	1.10	16.6	-1.04	15.4	-1.12	33.4	(0.04)	32.8
Brand	20.4	-0.78	37.6	1.36	27.3	(0.09)	26.6	(-0.01)	26.6
Equipment version	8.3	-0.59	12.5	0.27	16.7	1.11	10.4	(-0.15)	11.2
Shipping costs	1.3	-0.17	1.9	0.29	1.7	(0.15)	1.4	(-0.09)	1.5
Shipping time	1.8	-0.32	2.9	0.47	2.3	(0.02)	2.4	(0.08)	2.3
Customer reviews	2.3	-0.41	4.3	0.49	3.9	0.28	3.3	(0.01)	3.2
Condition	6.8	-0.48	7.0	-0.45	19.4	1.46	10.0	(0.01)	9.9
CO ₂ compensation	1.6	-0.22	2.6	0.41	1.9	(-0.03)	2.0	(0.02)	1.9
Product longevity	1.7	-0.18	2.5	0.29	2.0	(-0.01)	2.1	(0.04)	2.0
Fair production and trade	1.9	-0.15	2.7	0.32	1.9	(-0.14)	2.2	(0.06)	2.1
Eco-score	4.1	-0.58	9.4	0.79	7.6	0.31	6.3	(-0.01)	6.4
Sum of sustainable attributes	(9.3)	-0.56	(17.1)	0.84	(13.3)	(0.16)	(12.6)	(0.03)	(12.4)
<i>Psychographic consumer characteristic:</i>	Mean	t-value ^b	Mean	t-value ^b	Mean	t-value ^b	Mean	t-value ^b	Mean (SD)
Consciousness for sustainable consumption ^c	(SD)		(SD)		(SD)		(SD)		
Environmental consumption	4.00 (1.56)	(-0.05)	4.52 (1.62)	0.28	3.75 (1.65)	(-0.21)	4.07 (1.56)	(-0.00)	4.08 (1.60)
Social consumption	4.19 (1.59)	(-0.01)	4.44 (1.54)	(0.15)	3.80 (1.63)	-0.25	4.32 (1.64)	(0.07)	4.20 (1.61)
Simple consumption	5.84 (1.09)	0.16	5.53 (1.24)	(-0.11)	5.50 (1.33)	(-0.13)	5.59 (1.23)	(-0.05)	5.65 (1.21)
Debt-free consumption	5.44 (1.51)	(0.06)	5.30 (1.45)	(-0.03)	5.19 (1.69)	(-0.10)	5.35 (1.73)	(0.00)	5.34 (1.59)
Collaborative consumption	3.53 (1.78)	(-0.01)	3.90 (1.73)	0.20	3.03 (1.76)	-0.29	3.67 (1.81)	(0.07)	3.55 (1.79)
<i>Sociodemographic consumer characteristic:</i>	%	Chi-square test ^d (χ ² , df, p value)	%	Chi-square test ^d (χ ² , df, p value)	%	Chi-square test ^d (χ ² , df, p value)	%	Chi-square test ^d (χ ² , df, p value)	%
Gender		(0.995, 2, 0.608)		(0.434, 2, 0.805)		(0.796, 2, 0.672)		(1.379, 2, 0.502)	
Female	47.7		50.5		44.3		56.4		49.8
Male	52.3		49.5		54.6		42.9		49.8
Non-binary	0.0		0.0		1.0		0.8		0.4
Age		(18.91, 4, 0.001)		(12.59, 4, 0.013)		(4.930, 4, 0.295)		(0.809, 4, 0.937)	
18–29 years old	8.1		40.2		24.7		20.3		20.6
30–39 years old	14.7		20.6		25.8		18.1		18.7
40–49 years old	18.3		16.8		23.7		24.8		20.6
50–59 years old	34.5		13.1		13.4		22.6		23.4
60–69 years old	24.4		9.4		12.4		14.3		16.7
Highest educational achievement		(0.000, 4, 1)		(10.171, 4, 0.038)		(3.105, 4, 0.540)		(6.741, 4, 0.150)	
Secondary modern school qualification without completed vocational training	12.2		6.5		10.3		10.5		10.3
Secondary modern school qualification with completed vocational training	31.0		26.2		24.7		27.8		28.1
Secondary school certificate	39.1		30.8		38.1		30.8		35.2
University entrance qualification	7.6		15.9		14.4		15.8		12.6
University degree	10.2		20.6		12.4		15.0		13.9
Monthly net household income		(6.106, 7, 0.528)		(3.403, 7, 0.845)		(4.841, 7, 0.679)		(1.028, 7, 0.994)	
Below €1500	19.8		12.2		11.3		15.0		15.5
€1500–€1999	17.3		12.2		9.3		12.0		13.5
€2000–€2499	11.7		15.9		11.3		11.3		12.4
€2500–€2999	13.7		10.3		15.5		16.5		14.0
€3000–€3499	12.2		8.4		15.5		12.0		12.0
€3500–€3999	11.7		13.1		6.2		9.8		10.5
€4000–€4999	7.1		12.2		17.5		9.0		10.5
€5000 and more	6.6		15.9		13.4		14.3		11.6

^a Cluster analysis based on each respondent's relative importances for the mobile phone attributes measured in the adaptive choice-based conjoint analysis; method: K-means clustering; number of clusters chosen by plotting the within groups sum of squares by the number of clusters extracted (elbow criterion).

^b Normalised values, whereby negative (positive) t-values indicate that a variable is underrepresented (overrepresented) compared to the survey population; brackets signal that the deviations from the survey population are not significantly different from zero based on one sample t-tests with a 95 % confidence interval.
^c Based on the short version of the scale of consciousness for sustainable consumption (Ziesemer et al., 2016); each construct represents the weighted mean value of the associated items (weighted by their factor loadings, see Appendix S2); the items for each constructs are based on seven-point Likert scales anchored by 1 (= does not apply at all) and 7 (= fully applies).
^d df = degrees of freedom.

Table 5
 Multinomial logistic regression analysis results of the psychographic and sociodemographic characteristics.

Independent variable	Cluster													
	1 'Price shopper'				2 'Brand and eco shopper'					3 'New and equipment shopper'				
	Regression parameters ^a (n = 534)				p value ^c	Regression parameters ^a (n = 534)				p value ^c	Regression parameters ^a (n = 534)			
B	SE	Exp (B)	% Δ ^b	B		SE	Exp (B)	% Δ ^b	B		SE	Exp (B)	% Δ ^b	
<i>Psychographic consumer characteristic:</i>														
Consciousness for sustainable consumption ^d														
Environmental consumption	-0.070	0.081	0.932	-7		0.213	0.102	1.238	24	*	-0.056	0.095	0.946	-5
Simple consumption	0.215	0.112	1.239	24	+	-0.101	0.132	0.904	-10		0.063	0.123	1.065	7
Debt-free consumption	-0.016	0.083	0.984	-2		0.001	0.100	1.001	0		-0.043	0.094	0.958	-4
Collaborative consumption	-0.002	0.072	0.998	0		-0.003	0.086	0.997	0		-0.208	0.090	0.812	-19
<i>Sociodemographic consumer characteristic:</i>														
Gender														
Female	-0.435	0.247	0.647	-35	+	-0.296	0.286	0.744	-26		-0.549	0.293	0.577	-42
Male ^e														
Non-binary	-12.125	0.000	0.000	-100	***	-15.443	0.000	0.000	-100	***	0.053	1.585	1.055	5
Age														
18–29 years old ^e														
30–39 years old	0.754	0.456	2.126	113	+	-0.992	0.429	0.371	-63	*	-0.063	0.443	0.939	-6
40–49 years old	0.568	0.439	1.765	76		-1.523	0.430	0.218	-78	***	-0.530	0.439	0.588	-41
50–59 years old	1.286	0.427	3.620	262	**	-1.650	0.451	0.192	-81	***	-1.077	0.479	0.341	-66
60–69 years old	1.335	0.461	3.799	280	**	-1.607	0.511	0.201	-80	**	-0.449	0.515	0.638	-36
Highest educational achievement														
Secondary modern school qualification without completed vocational training	-0.289	0.431	0.749	-25		0.558	0.576	1.747	75		-0.107	0.534	0.899	-10
Secondary modern school qualification with completed vocational training ^d														
Secondary school certificate	-0.031	0.430	0.969	-3		0.427	0.571	1.533	53		0.200	0.524	1.221	22
University entrance qualification	-0.560	0.522	0.571	-43		-0.117	0.614	0.890	-11		-0.217	0.594	0.805	-19
University degree	-0.126	0.559	0.881	-12		0.725	0.656	2.064	106		-0.318	0.656	0.727	-27
Monthly net household income														
Below €1,500 ^e														
€1500–€1999	-0.144	0.437	0.866	-13		0.314	0.552	1.369	37		0.098	0.588	1.103	10
€2000–€2499	-0.611	0.467	0.543	-46		0.709	0.550	2.032	103		0.165	0.585	1.179	18
€2500–€2999	-0.531	0.430	0.588	-41		-0.138	0.548	0.871	-13		0.260	0.536	1.296	30
€3000–€3499	-0.450	0.460	0.638	-36		-0.197	0.589	0.822	-18		0.441	0.556	1.555	55
€3500–€3999	-0.224	0.482	0.799	-20		0.693	0.572	2.000	100		-0.168	0.659	0.845	-15
€4000–€4999	-0.587	0.530	0.556	-44		0.400	0.592	1.492	49		1.004	0.588	2.730	173
€5000 and more	-1.244	0.546	0.288	-71	*	0.383	0.582	1.467	47		0.453	0.606	1.574	57
Constant	-0.496	0.770	0.609	-39		-0.062	0.884	0.940	-6		0.871	0.870	2.389	139
Likelihood ratio test χ^2	110.919 (df = 9, p value = 0.000)													
Nagelkerke R ²	0.270													

^a B is the regression coefficient and Exp(B) the odds ratio; cluster 4 'Average shopper' serves as a reference category.
^b Percent of change in the odds of belonging to the respective cluster, % Δ = (Exp(B) - 1)*100.
^c Based on the Wald test; +p ≤ 0.10; *p ≤ 0.05; **p ≤ 0.01; ***p ≤ 0.001.
^d Based on the short version of the scale of consciousness for sustainable consumption (Ziesemer et al., 2016); each construct represents the weighted mean value of the associated items (weighted by their factor loadings, see Appendix S2); the items for each construct are based on seven-point Likert scales anchored by 1 (= does not apply at all) and 7 (= fully applies); consciousness for social consumption is removed from the analysis as a result of multicollinearity check.
^e Reference category.

compared to sectors like food. Although research on the social demographics of sustainable consumers generally shows mixed results, many studies find that sustainable consumers tend to be younger and better educated (e.g. Brécard et al., 2009; Krause and Battenfeld, 2019)

like the brand and eco shoppers. Similar to Mugge et al. (2017) who find that the consumer segment least interested in refurbished mobile phones is older than the sample average, we also find that the segment least interested in the eco-score (price shoppers) is older than the German

adult population. Overall, previous segmentation studies on sustainable mobile phones have largely focused on reuse, or other specific sustainability features (e.g., [Mugge et al., 2017](#); [Boyer et al., 2021b](#)), but not on comprehensive environmental labels like the eco-score. Our results contribute new insights by identifying segments that respond positively to a more holistic sustainability label and by characterising their CSC across multiple dimensions. We believe that this segmentation approach represents a meaningful extension of prior research.

5.2. Practical implications

The results of this study are of practical relevance especially for manufacturers, retailers and policy makers to develop effective sustainability management and marketing strategies as well as sustainability labelling schemes. Most promising is the empirical evidence that the hypothetical eco-score has an almost linear, positive effect on mobile phone purchase preferences across the tested eco-score range. This suggests that not only small but also large improvements in the environmental performance of mobile phones – up to a certain threshold – are rewarded by consumers so that there are incentives for companies to offer and label mobile phones with a particularly strong environmental performance. However, this relationship may plateau at higher levels of environmental performance, where further improvements are no longer captured by the eco-score and may not significantly influence purchase preference. For policy makers, it implies that they should test the introduction of a holistic eco-score label for consumer electronics, which presents aggregated environmental impacts on a simple colour-coded scale (e.g. A to E, green to red), similar to energy efficiency labels. Unlike in the food or clothing market, there are only a few sustainability labels for specific aspects of environmental sustainability of consumer electronics. The early introduction of an aggregated eco-score in the consumer electronics industry could thus avoid a multiplicity and an overload of sustainability labels from the outset.

We also recommend that marketers of sustainable mobile phones develop separate marketing strategies for each of the sustainability-sensitive segments. Both segments are the least price-sensitive and account for about 38 % of the nearly population-representative survey population, indicating a high untapped market potential for sustainable mobile phones in Germany. Rather than broadly targeting all consumers, marketers of sustainable mobile phones should primarily tailor their marketing strategies to the more sustainability-sensitive brand and eco shopper segment, for example by communicating environmental benefits - including those related to refurbishment - and collaborative use aspects, which resonate particularly strongly with this group. They should also use an eco-score label if possible. Manufacturers of conventional, high-end mobile phones who want to improve in the area of environmental product performance should focus on the new and equipment shoppers. For them, marketers should offer new, high-performance mobile phones, ideally labelled with an at least good eco-score, and primarily communicate the individual benefits related to the conventional mobile phone attributes. Moreover, it could be an opportunity to sell refurbished mobile phones at a low price to the price shopper segment, as it is little relevant to them whether the mobile phone is new or a type of used phone. Their above-average consciousness for simple consumption should also be considered by corresponding sufficiency-oriented marketing strategies (cf. [Gossen et al., 2019](#); [Niesen and Bocken, 2021](#)).

Consequently, our results suggest an update of the three-tier distribution system of [Boyer et al. \(2021b\)](#), where only one mobile phone is sold three times, each time to a new customer segment. A possible solution for manufacturers and retailers is a three-tier distribution system, in which two sustainably produced mobile phone models (a high-performance premium model and an averagely equipped mid-range model) are each sold to at least two segments. While the sustainable premium model targets the performance-sensitive new and equipment shopper segment, the sustainable mid-range model can be

marketed to the brand and eco shoppers. After the first phase of use, the products are returned and prepared for refurbishment and reuse. The used premium model could then be sold to the brand and eco shoppers, while the used mid-range model could be sold at a lower price to the price shoppers. In another round of take-back and resale, the double refurbished premium mobile phone could be marketed to the price shoppers.

In addition, distribution and communication channels that appeal to younger and better educated consumers may be favoured when targeting brand and eco shoppers. Younger generations form the largest market segment for online shopping in most countries of the Global North ([Ladhari et al., 2019](#)) and place more importance on sustainability labels than older generations when shopping online ([Brand et al., 2022](#)). Therefore, marketers could effectively target the brand and eco shopper segment via online distribution and communication channels.

Overall, our findings are potentially interesting for a broader range of industries. For example, the fashion sector tends to be characterised by a multitude of sustainability labels and a lack of harmonisation in communicating sustainability ([Gonçalves and Silva, 2021](#)), which can lead to untrustworthy and manipulative marketing strategies ([Gossen et al., 2022](#)). Therefore, the fashion sector might also benefit from testing a more holistic approach to sustainability labelling.

5.3. Limitations and future research

This study is not without limitations. First, the hypothetical eco-score tested reduces sustainability information to a simple decision criterion without a transparent source. [Weber \(2021\)](#) shows that a simple eco-score design leads to higher perceived relevance for consumers than an extended eco-score that includes complex sustainability information. Recent studies show that the eco-score has a positive effect on consumer choices and willingness to pay for sustainable food products - even when no additional information is provided ([Jürkenbeck, 2023](#)) and consumers' have no prior knowledge about the eco-score or eco-labels in general ([Kolber and Meixner, 2023](#)). However, as no information was provided about the sender of the eco-score, it is difficult to make assumptions about whether or why the eco-score was perceived as credible by respondents in this study. Therefore, and in line with the EU Commission's proposal for a Green Claims Directive (cf. [European Commission, 2023](#)), we recommend that future studies in the consumer electronics sector clearly state who tested and issued sustainability information such as the eco-score and sustainability tags (e.g. manufacturer, retailer, or an independent third-party organisation) and whether or not it is legally binding. Additionally, a qualitative study could help to understand what the eco-score actually communicates to shoppers within the consumer electronics sector. It would also be interesting to have an explicit test of the effectiveness of the eco-score differentiated by sender information. Second, although it is common to use prohibitions in conjoint studies to increase respondents' perception of reality, they should be used in a reduced form to enable the estimation of interaction effects between product attributes. Therefore, we recommend that future studies avoid the use of prohibitions as much as possible and measure potentially interesting interaction effects. Third, although we made this decision deliberately in order to obtain sufficient preference data for the sustainable brands, we recommend that future studies try to avoid an overrepresentation of certain brands in their experimental design, as this may lead to an overestimation of the utility of these brands. Fourth, although the population is representative in terms of gender and age, the sample is not representative in terms of highest educational achievement compared to the German adult population. To achieve better generalisability of the results, we recommend that future studies ensure a high degree of representativeness, specifically across educational groups, of the population. Fifth, since the study was conducted solely in Germany; cultural, regulatory, and market-specific factors may have influenced consumer preferences. For instance, the relatively strong regulatory push for sustainability in

Germany may not be equally present in other countries. To improve external validity, future research should replicate the study in different national contexts and investigate cross-country differences, especially in eco-score preferences. Sixth, in view of a potential political debate on introducing an eco-score in the consumer electronics sector, research should also focus on the calculation of such an eco-score. Seventh, our study focuses only on one product category within the consumer electronics sector, namely mobile phones. Further research with other consumer electronics categories and across different sectors is needed to determine whether an eco-score can be an effective sustainability label on a larger scale.

Apart from that, we recommend the following avenues of future research. First, while our study shows that a multi-level eco-score has a positive impact on consumer preferences for mobile phones, future studies need to explore the relationship between an eco-score, consumers' willingness to pay, and pricing. Employing willingness-to-pay assessments, future studies could provide deeper insights into how eco-score rankings, in conjunction with pricing strategies, influence consumer purchase decisions and the market potential of sustainable mobile phones. Second, previous research on food suggests that the impact of an eco-score may be limited if it is provided together with the Nutri-Score (De Bauw et al., 2021). Future research should therefore investigate whether adding an eco-score label to existing consumer electronics labels, such as the EU energy efficiency label, may increase information overload for consumers and lead to ambivalent choices. Third, future studies need to evaluate how an eco-score for consumer electronics can be calculated in practice and thereby determine which aspects of environmental sustainability information should be aggregated. Fourth, future studies on a voluntary eco-score should also test the 'no eco-score' option to gain insights into whether companies should advertise with a poor or medium eco-score, rather than excluding the score as a label altogether. Fifth, researchers have pointed to the potential for cannibalisation of new product sales by remanufactured versions of the same product (Guide and Li, 2010; Linder and Willander, 2017). Further research could investigate how two similar products compete with each other and provide more details on how companies transitioning to sustainable product offers can reduce a possible cannibalising effect on their existing product lines. Sixth, future experimental studies may use incentives to trigger real financial transactions in order to improve realism of consumer reactions and preferences and thus utility estimations.

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CRedit authorship contribution statement

Kathleen Jacobs: Writing – review & editing, Writing – original draft, Visualization, Supervision, Software, Project administration, Methodology, Formal analysis, Conceptualization. **Jens Bergener:** Writing – review & editing, Writing – original draft, Methodology, Investigation, Conceptualization. **Maïke Gossen:** Writing – review & editing, Supervision, Resources, Conceptualization.

Declaration of competing interest

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

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Appendix: Supplementary data

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Data availability

Data will be made available on request.

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