









# Consumer preferences for sustainability labels: A comparative analysis of the green-score and other established labels

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## ABSTRACT

The Green-Score label aims to complement established certifications by providing a standardized and easily interpretable assessment of products' environmental performance. This study examines (i) the relative influence of Green-Score, organic, and Protected Designation of Origin (PDO) certifications on consumers' willingness to pay (WTP); (ii) how label effectiveness varies across food categories; and (iii) the impact of a salience nudge on consumer choices. A Discrete Choice Experiment was conducted with a nationally representative sample of 1,102 Italian consumers, using a between-subjects design to evaluate the nudge. Results show that PDO labels, leveraging strong institutional credibility and symbolic value, consistently generate the highest marginal WTP (€7.61), especially for culturally and traditionally significant products. Green-Score A+ labels, valued for their diagnosticity and cross-product comparability, achieve an average marginal WTP of €6.25, slightly above organic certification (€4.59), with variation across product categories and treatment conditions. The salience nudge enhances the perceived value of Green-Score, particularly in contexts where environmental performance is salient, and can reduce the marginal contribution of overlapping labels such as organic certification. These findings demonstrate that the effectiveness of sustainability labels depends on both the balance between credibility and diagnosticity and the product-specific context, offering actionable insights for policymakers and stakeholders seeking to design targeted and effective environmental labelling strategies in food markets.

## 1. Introduction

At the European level, the Farm to Fork Strategy, launched by the European Commission in 2020 as part of the European Green Deal, aims to make EU food systems more sustainable, healthy, and resilient. A key aspect of the strategy is to empower consumers to make informed, healthy, and sustainable food choices through a front-of-pack (FOP) labelling system. Thus, in addition to encouraging harmonised, mandatory nutritional FOP labels into EU food markets, the strategy aims to increase transparency regarding the environmental impact of food (through sustainability labelling) and to prevent 'greenwashing' (through Directive EU 2024/825). Closely aligned with this aim, the European Commission issued a recommendation in late 2021

advocating for the use of harmonised methods to assess environmental performance, specifically, the Product Environmental Footprint (PEF) and the Organisation Environmental Footprint (OEF- [European Commission, 2021](#)). Both approaches are based on the Life Cycle Assessment (LCA) methodology and aim to enhance scientific rigour and comparability in the evaluation of environmental impacts across the entire life cycle of products and organizations ([European Commission, 2021](#)).

In this light, several LCA-based food labelling schemes were developed to assess and communicate to consumers the environmental impacts of food products along their life cycle, including EnviroScore in Spain, the Eco-Impact score in the UK or the Eco-Score, now called Green-Score,<sup>1</sup> introduced by some retailers in France and Belgium ([De Bauw et al., 2022](#)). Drawing on the experience of Nutriscore, the Green-

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<sup>1</sup> The Green-Score is the new name for the Eco-Score, which was introduced in late 2024 after the French Court of Justice upheld petitions by IFOAM Organics Europe, and particularly the French IFOAM association, not to use the term 'eco', as this was considered to be unfair to organic producers and deceptive to consumers.

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Score is based on the use of colour coding, inspired by the traffic light model, to facilitate more intuitive consumer understanding (Rizzo et al., 2025; Hémar-Nicolas et al., 2024; De Bauw et al., 2022; Edenbrandt and Lagerkvist, 2021). Specifically, this label summarises the overall environmental impact into accessible formats, providing a holistic assessment of a product's sustainability (De Bauw et al., 2022). Its goal is to help consumers identify products with lower environmental impacts across different dimensions, including greenhouse gas emissions, water usage, transportation, and resource depletion (Vlaeminck et al., 2014).

Compared to well-established sustainability-related food attributes, such as organic or Protected Designation of Origin (PDO) certifications, emerging labels, such as the Green-Score, assess the sustainability of all products within a given food category, rather than only those certified under a specific scheme. Moreover, these labels are based on the measurement of multiple environmental impact indicators, rather than relying solely on process-based criteria. Hence, understanding how consumers value different types of sustainability labels, particularly the Green-Score vis-a-vis organic certification, and PDO, is critical given their fundamentally different bases and implications.

From a theoretical perspective, these differences can be interpreted through the lens of Signalling theory (Spence, 1973). Food labels function as signals that reduce information asymmetries between producers and consumers by credibly conveying otherwise unobservable product attributes. However, signals may be perceived differently by consumers. Indeed, established certifications such as PDO and organic are highly institutionalised, familiar, and socially embedded, making them credible and easily interpretable signals of quality, authenticity, and sustainability (Aprile et al., 2012; Garavaglia & Mariani, 2017). By contrast, the Green-Score is a relatively novel, science-based signal that, while comprehensive and rigorous, may lack the cultural resonance and symbolic capital of long-standing certifications.

Thus, understanding how consumers interpret and value these signals is essential to assess potential complementarities or conflicts among them. This comparison is important and particularly timely as policymakers and stakeholders consider the harmonisation of sustainability labelling systems at the EU level. Empirical insights into how these labels perform, individually and relative to one another, can help ensure that future labelling frameworks are both scientifically robust and aligned with consumer preferences, thereby maximizing their effectiveness in promoting sustainable consumption.

Despite increasing academic and policy interest in sustainability labelling, important knowledge gaps remain. Previous studies have yielded mixed findings regarding consumer preferences for the Green-Score compared to more established certifications. Some have found that the Green-Score is a dominant attribute influencing choice, while others report a stronger preference for organic certification (De Bauw et al., 2022; Shaikh et al., 2024). These divergent results raise questions about how signals are interpreted and prioritised when multiple sustainability labels coexist.

Moreover, existing research has largely evaluated these labels within single product categories, limiting our understanding of how performance may vary across product types. For instance, sustainability cues may reduce perceived authenticity in hedonic products like wine (Fantechi et al., 2025), carry more weight in plant-based staples, or be deprioritized in animal-based goods where concerns about animal welfare may dominate (Van Loo et al., 2014; De Bauw et al., 2022; Ammann et al., 2025). Without a cross-category perspective, policymakers risk developing labelling strategies that are unevenly effective, or even counterproductive, across different food sectors.

In addition to understanding preference structures, there is a need to examine how behavioural interventions can amplify the impact of sustainability labels. While such signals can influence stated preferences, their effect on actual consumer behaviour is often limited (Grunert et al., 2014). Behavioural nudges, especially those that enhance the salience of environmental information at the point of decision, may bridge this gap. By increasing the cognitive accessibility of sustainability considerations,

nudges can make environmental impacts more immediate and influential in shaping choices. Understanding how salience-enhancing interventions interact with sustainability labelling is therefore crucial for designing effective, evidence-based policy tools that encourage sustainable consumption.

Building on these considerations and to fill gaps in the literature, this study pursues three main objectives: *i*) examining the effect of emerging sustainability labels, specifically the Green-Score, in comparison to well-established sustainability labels, such as organic and PDO certifications; *ii*) assessing whether the effect of the Green-Score, relative to well-established labels, varies according to product category, specifically between hedonic and experiential items, plant-based products, and animal-based products; *iii*) evaluating whether a salience nudge that increases awareness of the sustainability implications of consumption choices can encourage greater use of sustainability labels.

To address these objectives, the study focuses on three food categories: wine, extra-virgin olive oil (EVOO), and buffalo mozzarella. These were purposefully selected as representative of distinct consumption logics and value dimensions: wine as a hedonic and experiential good, EVOO as a plant-based staple with strong utilitarian and culinary associations, and buffalo mozzarella as a highly symbolic animal-based product, often linked to quality, origin, and animal welfare. Their selection can be further justified by their cultural relevance, consumer behaviour patterns, and environmental impact within the Italian context. Wine is typically linked to conviviality and hedonic motivations (Fantechi et al., 2025); EVOO functions both as a culinary ingredient central to Mediterranean diets and as a utilitarian staple tied to everyday cooking and health concerns (Del Giudice et al., 2015); while buffalo mozzarella exemplifies a symbolic animal-based product in which concerns for animal welfare, production practices, and territorial identity often prevail (Trabalzi, 2007).

Moreover, all three categories are widely available with PDO and organic certifications, providing a credible setting for examining the signalling role of established labels. At the same time, they represent suitable candidates for the introduction of emerging sustainability schemes such as the Green-Score, which may complement existing certifications and reshape consumer evaluation. Finally, their environmental implications differ markedly: wine production is resource- and carbon-intensive (Christ & Burritt, 2013), olive oil cultivation raises issues related to land use and agricultural practices (Scheidel & Krausmann, 2011), and buffalo mozzarella entails a particularly high carbon and water footprint due to dairy farming (Grossi et al., 2024). This heterogeneity across cultural, behavioural, certification, and environmental dimensions makes them particularly suited to investigating how consumers value sustainability labels in diverse food categories.

This study adopts a Discrete Choice Experiment (DCE), administered to a nationally representative sample of 1102 Italian consumers. The experiment was designed to assess consumer preferences for four key attributes: the Green-Score label, organic certification, PDO certification, and price. Using a between-subjects experimental design, the study compares outcomes between a control group and a treatment group exposed to a salience nudge, specifically, a video designed to heighten awareness of the sustainability consequences of consumption choices. This approach allows for the assessment of whether increased salience of sustainability impacts consumers' propensity to select products bearing sustainability labels.

## 2. Theoretical framework and hypotheses development

### 2.1. Sustainability labels as market signals: Credibility and diagnosticity

Food markets are characterized by pronounced information asymmetries, as consumers cannot directly observe credence attributes such as sustainability, authenticity, or production methods. Signalling theory (Spence, 1973) provides a useful lens to understand how labels and certifications reduce such asymmetries by acting as observable signals.

However, signalling theory also emphasizes that the effectiveness of a signal does not depend solely on its presence, but on how it is interpreted by consumers, particularly in terms of its credibility and diagnosticity<sup>2</sup> (Atkinson & Rosenthal, 2014; Moussa & Touzani, 2008). In the Italian food context, established certifications such as PDO and organic have historically functioned as credible signals, supported by institutional backing, regulatory frameworks, and cultural embeddedness. Prior research shows that these labels can enhance consumer trust and increase willingness to pay (WTP) by conveying information related to origin, production standards, and environmental practices (Scarpa et al., 2007; Zanoli et al., 2013; Roselli et al., 2018). Specifically, PDO certifications convey relatively specific and verifiable information regarding product origin, typicality, and production methods, enabling consumers to differentiate products and infer quality attributes that are closely aligned with their consumption goals (Scarpa et al., 2007). In food categories where territorial identity and authenticity are particularly salient, PDO labels therefore function not only as highly credible signals, but also as comparatively diagnostic cues at the point of choice. Conversely, organic certification, while generally perceived as credible due to its regulatory framework and long-standing market presence, conveys a broader and more aggregated sustainability claim (e.g., input use, farming practices, and environmental safeguards). Its binary nature (organic vs. conventional) and coverage of multiple production dimensions without specifying relative environmental performance can make it less diagnostically informative for guiding comparisons among labelled alternatives (Janssen & Hamm, 2012; Grunert et al., 2014).

At the same time, emerging labels such as the Green-Score represent a different form of sustainability signalling. Rather than relying on tradition or institutional familiarity, the Green-Score aims to increase signal diagnosticity by simplifying complex environmental information into an intuitive and easily interpretable format. While its novelty may initially raise concerns regarding credibility, its standardized and comparative nature may enhance its informational value, particularly for consumers seeking clear guidance at the point of choice.

From a signalling perspective, established and emerging sustainability labels rely on different mechanisms. While traditional certifications primarily draw on institutional trust and symbolic meaning, newer labels such as the Green-Score emphasize cognitive accessibility and comparative informativeness. Rather than assuming the a priori superiority of one type of signal, their relative impact on consumer WTP is therefore expected to depend on how consumers trade off credibility and diagnosticity at the point of choice. Accordingly, the following hypothesis is proposed:

H1. *Sustainability labels exert heterogeneous effects on consumers' WTP as a function of the signalling mechanism they primarily rely on, namely institutional credibility or diagnosticity.*

## 2.2. Product category as a boundary condition for sustainability signalling

Signalling theory further suggests that the interpretation and effectiveness of market signals are inherently context-dependent, as signals are evaluated relative to category-specific expectations and salient quality dimensions (Mauri et al., 2021). Food product categories differ systematically in terms of consumer involvement, perceived risk, and the relative importance of credence attributes such as origin, healthfulness, and ethical production practices (Cardello et al., 2022). As a result, the same sustainability or quality label may convey different meanings and exert different signalling value across product categories.

In categories where quality perceptions are closely tied to territorial

<sup>2</sup> Credibility refers to the extent to which a signal is perceived as legitimate and trustworthy, often grounded in its historical establishment as a recognized market cue, whereas diagnosticity captures the degree to which the signal provides precise, relevant, and decision-useful information for specific consumer goals.

identity and tradition, such as wine, origin-based certifications like PDO are likely to function as highly diagnostic signals (Fantechi et al., 2025). In contrast, in categories associated with everyday consumption and health-related motivations, such as extra-virgin olive oil, organic certification may be more salient due to its alignment with consumers' health and naturalness concerns (De Bauw et al., 2022). For animal-based products, ethical considerations related to production practices and animal welfare often constitute dominant evaluative criteria, potentially reshaping how sustainability signals are interpreted (Van Loo et al., 2014).

Emerging labels such as the Green-Score introduce a standardized, cross-category sustainability metric that is, by design, less tied to category-specific attributes (Taillie et al., 2024). While this standardization may enhance comparability across products, it may also limit the label's perceived relevance in categories where consumers prioritize category-specific quality or ethical dimensions. From a signalling perspective, this creates a potential tension between generic sustainability metrics and category-embedded certifications, implying that the effectiveness of the Green-Score may vary depending on how well its informational content aligns with category-specific expectations.

Taken together, these considerations suggest that product category constitutes a key boundary condition for sustainability signalling, shaping both the relevance and the diagnosticity of different labels. Based on this reasoning, the following hypothesis is proposed:

H2. *Consumers' valuation of sustainability and quality labels (PDO, organic, Green-Score) differs across wine, EVOO, and buffalo mozzarella, reflecting category-specific differences in the signalling relevance of these labels.*

This hypothesis does not posit a priori superiority of any specific label within a given category but predicts systematic cross-category heterogeneity in label valuation driven by differences in signalling relevance.

## 2.3. Salience nudges and the conditional effectiveness of sustainability signals

The use of sustainability signals has increased substantially in recent years as a means of guiding consumers toward more environmentally friendly food choices. Established certifications, such as organic and PDO, alongside emerging schemes such as the Green-Score, function as heuristic cues that convey otherwise unobservable sustainability attributes and translate abstract environmental values into actionable purchasing decisions (Asioli et al., 2020). However, despite their growing diffusion, empirical evidence consistently shows that consumers' actual reliance on sustainability labels remains limited. As highlighted by Grunert et al. (2014), a persistent attitude-behaviour gap characterizes food consumption, whereby stated pro-environmental concerns frequently fail to translate into observed purchasing behaviour. This discrepancy underscores the importance of enhancing the salience and cognitive accessibility of sustainability-related information at the point of choice (De Cianni et al., 2024).

From a behavioural economics perspective, salience nudges can address this gap by increasing the perceptual prominence of existing information without changing the underlying choice architecture (Blumenthal-Barby & Burroughs, 2012). Within a dual-process framework, such nudges primarily operate through fast, intuitive (Type 1) processes, redirecting consumers' attention toward specific cues at the moment of decision-making (Houlihan, 2018). In doing so, salience nudges do not introduce new information, but rather alter the relative weight assigned to existing signals by making them more cognitively accessible.

Importantly, the effectiveness of salience nudges is conditional. That is, when a label is perceived as informative, relevant, and trustworthy, increased salience can strengthen its influence on choice. Conversely, when a label is highly familiar, taken for granted, or weakly linked to the consumer's decision goal, additional salience may produce limited, null,

or even negative effects (Stuber et al., 2021; Weimer et al., 2022). Moreover, product category moderates these effects. In categories where sustainability attributes are closely tied to core quality dimensions, such as origin and tradition in wine, or ethical concerns in animal-based products, salience nudges may amplify category-relevant labels, while their impact is weaker for less diagnostic signals.

Emerging labels such as the Green-Score, which provide synthetic and easily interpretable environmental information, may benefit particularly from increased salience, enhancing both visibility and perceived diagnosticity. In contrast, well-established labels like organic, already associated with broad and diffuse benefits, may see smaller or even negative incremental effects when made more salient.

While earlier studies have predominantly relied on written or informational prompts, evidence suggests that visual and multimedia interventions can more effectively capture attention and enhance intuitive processing. Volandes et al. (2009) demonstrate that video-based stimuli increase emotional engagement and information retention compared to static or text-based formats. By simultaneously activating visual and affective processing channels, video-based salience nudges can make sustainability information more vivid, concrete, and immediately accessible during choice, thereby increasing the likelihood that highlighted labels are incorporated into intuitive decision-making.

Although evidence on the overall effectiveness of nudges remains mixed (Shaikh et al., 2024; de Visser Amundson et al., 2025; Elofsson et al., 2016), recent findings suggest that well-designed nudges incorporating salient visual elements can amplify both the informational and symbolic value of sustainability labels. Based on these considerations, the following hypothesis is proposed:

H3. *The effect of a salience video nudge on consumers' WTP for sustainability-labelled products is contingent on both the type of label and the product category, as salience alters the perceived credibility and diagnosticity of the label at the point of choice.*

### 3. Methodology

#### 3.1. Sample and survey design

As previously stated, a Discrete Choice Experiment (DCE) was conducted to test the research hypotheses formulated in this study. DCEs are commonly employed in food policy research, as they enable the assessment of policy impacts on individual welfare, as well as the estimation of marginal utilities and marginal willingness to pay (mWTP) for various labelling schemes. DCE data were collected in April 2025 through an online survey administered by a professional market research agency. The study was conducted in accordance with the ethical principles of the Declaration of Helsinki, all respondents provided informed consent, and responses were collected anonymously. The sample was designed to be representative of the adult Italian population in terms of age, sex at birth, educational level, and geographic distribution across national residential areas. Participants were screened to ensure they were responsible and co-responsible for their household food purchase and consumed wine, EVOO, and buffalo mozzarella at least once in the past year.

The survey instrument consisted of a structured questionnaire divided into four sections. The first section gathered information on participants' consumption habits, including the frequency of consumption of wine, EVOO, and buffalo mozzarella, as well as their consumption of organic and PDO products. Specifically, the frequency of consumption of certified products over the past year was measured through a seven-point frequency scale from 'Every day' to 'Rarely'.

The second section presented a series of choice tasks used to conduct a DCE focused on the three selected products (further details are provided in the experimental design section). The instrument comprised eleven items from the General Health Interest (GHI) scale (Roininen et al., 1999), four items assessing environmental concern, and two items evaluating respondents' social norms. An example item was the follow:

'People who are important to me think that I should eat products with a low environmental impact'. All items were rated on a 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree).

This section also included attention checks to ensure data quality. Respondents who failed it have been excluded from the analysis. Finally, the fourth section collected socio-demographic information. The survey took approximately 20 min to complete. The study was preregistered on the OSF platform (<https://doi.org/10.17605/OSF.IO/E5WTS>) and received ethical approval from the Bioethics Committee of the University of XXXXX (approval certificate No. 296/2025).

#### 3.2. Experimental design

A Bayesian efficient design was used to generate the choice experiment. A pilot study was conducted with a sample of 95 respondents. Using a multinomial logit (MNL) model, the mean and standard deviation of the distribution of the estimated coefficients were assessed. Coefficient estimates and standard errors were subsequently used as priors for constructing the Bayesian efficient design.

The final design included six choice sets per product, resulting in a total of 18 choice tasks across the three products. The sample size was determined to be about 890 based on an a priori power analysis conducted using G\*Power 3.1, accounting for a small effect size ( $f^2 = 0.18$ ) with a statistical power of 0.85 and a significance level ( $\alpha$ ) of 0.05 (Faul et al., 2009). Moreover, the sample size was increased by approximately 10% beyond the value suggested by the G\*Power analysis to account for potential anomalies, such as failed attention checks or inconsistent responses. Thus, the final sample consisted of 1102 Italian consumers older than eighteen. To estimate the effect of the behavioural nudge information treatment, a between-subject design was applied. After the initial screening, participants were randomly assigned to two experimental conditions: a Control Group ( $n = 541$ ) and a Treatment Group ( $n = 561$ ). Participants received the questionnaire, which was identical for both groups, except for the second section, where participants in the treatment group received a salience nudge before starting the DCE tasks.

As stated before, the behavioural nudge was delivered through a video clip emphasizing the importance of protecting the environment through daily actions. Specifically, it highlighted how individual choices can make a difference for future generations and encouraged collective efforts for a greener and safer planet. The intervention in this study was implemented in the same spirit as previous nudging studies that targeted pro-environmental behaviour in different contexts, such as Ouvrard et al. (2020) and Vella et al. (2025) with farmers, Song et al. (2024) with tourists and Emberger-Klein & Menrad, (2018) with consumers. To ensure recognition of the nudge's message, a manipulation check was included (see the Appendix A).

Furthermore, a brief description of the attributes (see Appendix B) and levels considered in the DCE was provided. Specifically, we used four attributes to describe the different types of products: Green-Score label, PDO certification, organic certification, and price (see Table 1). For this study, two European certification systems, organic production, identified by the European leaf label, and PDO, marked by the corresponding official EU label, were selected as indicators of more sustainable purchasing options compared to conventional products. These certifications were chosen due to their widespread recognition and long-standing regulatory presence at the European level. Following previous research, the two certifications were treated as separate attributes, each with two levels (presence vs. absence), since both labels may appear simultaneously on a single food product (Aprile et al., 2012; Bazzani et al., 2017).

The Green-Score attribute appeared with three levels, A+, C, and F, corresponding to the two extremes and the midpoint of the seven-level Green-Score scale. Specifically, level A+ indicates a very low environmental impact, level F signifies a very high impact, and level C represents a moderate impact. This categorization aligns with the approach adopted by Xiong et al. (2024), who utilized a similar carbon label

**Table 1**  
Attributes and Levels in the DCE.

Attributes	Levels	
Green-Scorelabel	- A+	
	- C	
	- F	
Organic certification	- Organic	
PDOcertification	- None	
	- PDO	
Prices:	- None	
Wine		€5; €6,30; €7,80; €9,80; €12,20; €15,30
EVOO		€6; €7,50; €9,40; €11,70; €14,60; €18,30
Buffalo Mozzarella		€3,50; €4,40; €5,50; €6,80; €8,50; €10,70

attribute, as well as Hughes et al. (2024), who applied a three-level color-coded labelling system to communicate environmental impact, with red denoting high, yellow medium, and green low impact. In the choice tasks, each Green-Score level was visually represented by a leaf-shaped icon coloured green for A+, yellow for C, and red for F.

The decision to restrict the Green-Score to three levels was driven by the need to minimize cognitive overload among participants. As Caputo and Scarpa (2022) emphasize, an excessive number of attributes or levels can increase task complexity, leading respondents to rely on cognitive shortcuts instead of engaging in deliberate decision-making. Therefore, a limited yet representative number of levels was selected, consistent with established best practices in DCE design. Lastly, six price levels were specified based on current market prices for wine, extra virgin olive oil (EVOO), and buffalo mozzarella in retail stores in Italy: from €5.00 to €15.30 for wine; from €6.00 to €18.30 for EVOO; and from €3.50 to €10.70 for buffalo mozzarella. As also done by Bazzani et al. (2024), a wide price range was selected to reflect the possible price alternatives available on the Italian market. This includes higher price values, which may represent a limited segment of the market for these products in Italy.

Before starting the choice experiments, participants were introduced to the choice tasks and exposed to a ‘cheap talk script’ (see Appendix C)

designed to encourage truthful answers and reduce hypothetical bias, in particular the tendency to overestimate WTP. During the choice tasks, the order of product presentation was randomized across respondents to mitigate potential position bias. After indicating their choices, we provided Attribute Non-Attendance (ANA) questions at the end of all choice cards framed as follows: ‘Based on the options listed above, please indicate how often you paid attention to each attribute’. Responses were measured on a five-point scale ranging from ‘Never’ to ‘Always’.

To provide an overview of the study structure and procedures, Fig. 1 presents the design at a glance. Fig. 2.

### 3.3. Model estimation in WTP-space and computation of individual-specific WTP

To analyse the individual-specific WTP estimates for each attribute included in the DCE a multi-step procedure was followed. Based on the random utility theory of McFadden (1973) and the theory of consumer behaviour of Lancaster (1966), we firstly estimated the mixed logit model directly in WTP space, using the STATA module *mixlogitwtp* (Hole and Kolstad, 2012). Previous studies have shown that models estimated in the willingness to pay (WTP) space tend to fit better data and to produce more interpretable estimates than models estimated in the preference space (Thiene & Scarpa, 2009; Scarpa et al., 2008). Consequently, this modelling approach has been adopted by an increasing number of studies in various fields, including food economics (Caputo et al., 2018; Asioli et al., 2023).

The utility specification was the following:

$$U_{ijt} = \alpha_i \left( ASC - Price_{ijt} + \beta_1 Green Score A^+_{ijt} + \beta_2 Green Score C_{ijt} + \beta_3 Organic_{ijt} + \beta_4 PDO_{ijt} \right) + \epsilon_{ijt} \quad (1)$$

where  $i$  refers to individuals,  $j$  and  $t$  index respectively alternatives and choice situations. In the Eq. (1) the  $\alpha_i$  indicate the price scale parameter supposed to be log-normal distributed and random among respondents.  $\beta_1, \beta_2, \beta_3, \beta_4$  are the estimated mWTP values for Green-Score A+, Green-Score C, organic and PDO, respectively. ASC is the alternative specific constant representing the no-buy option. The price attribute ( $Price_{ijt}$ ) represents the six levels of prices for each product.

In this model specification, the attributes considered include Green-Score, organic certification, and PDO certification. The Green-Score is represented by two dummy variables, coded as 1 when the product is rated A+ or C, and 0 when rated F, the baseline category representing the lowest environmental performance.

Accordingly, the estimated coefficients  $\beta_1$  and  $\beta_2$  for A+ and C reflect the change in utility, hence, the change in WTP, relative to a product labelled with a Green-Score of F.

Finally,  $\epsilon_{ijt}$  is an unobserved random term that is distributed following an extreme value type I distribution, independent, and identically distributed (i.i.d.) over alternatives. The attributes Green-Score, organic and PDO certifications were modelled as random parameters, while the no-buy option was modelled as a fixed parameter.

Different model specifications were estimated using varying numbers of simulation draws, incorporating both correlated and uncorrelated random parameters. Based on Log-Likelihood, AIC, and BIC parameters, the best model was with five hundred Halton draws with correlated variables.

Furthermore, the differences in mWTP between the two conditions (control and treatment groups) were tested using bootstrap methods. Differences in mean WTP were estimated through 1000 bootstrap replications, and confidence intervals were computed. Two-sided Poe tests were performed to assess statistical significance (Poe et al., 2005).

We also estimated additional random parameter logit models in WTP space including interaction terms between the Green-Score levels (A+ and C) and established quality labels (organic and PDO). Separate models were estimated for each product category and experimental

<u>Design:</u>	DCE; Between-subjects design (Control Vs. Treatment).
<u>Sample:</u>	Italian consumers responsible (at least in part) for household food purchases;
<u>Products:</u>	3 products (Wine; EVOO; Buffalo mozzarella).
<u>Treatment</u>	Salience nudge delivered through a short video.
<u>Tasks:</u>	18 choice tasks; 2 alternatives and No-buy option.
<u>Attributes:</u>	Price; Green-Score; organic certification; PDO.
<u>Outcome:</u>	mWTP by label/product; Treatment effects.
<u>Analysis:</u>	Mixlogit (WTP space) + Latent Class Analysis;
<u>Key findings:</u>	Control groups: $mWTP_{PDO} > mWTP_{Green\ Score} > mWTP_{Organic}$ ; Salience increased mWTP for Green-Score (A+ and C) and PDO, reduced organic certification in EVOO, and showed no effect in wine.

Fig. 1. Design at a glance.

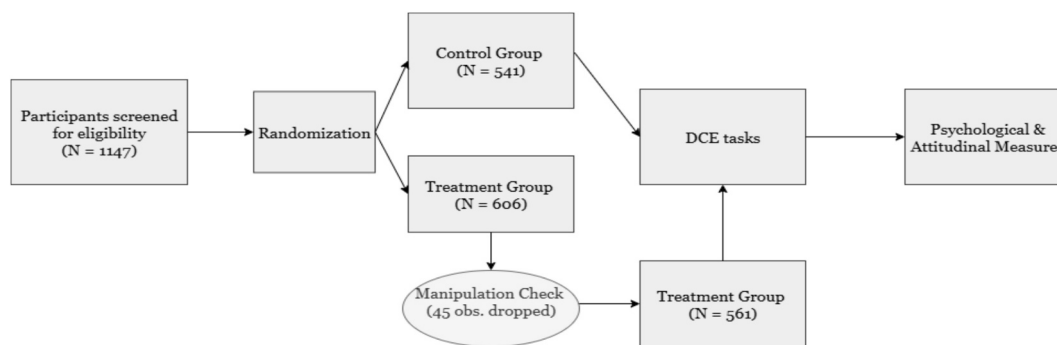


Fig. 2. Experimental Procedure.

condition (control and salience treatment), allowing the interaction effects to be assessed in a context-specific manner.

These interaction terms capture how consumers combine multiple sustainability and quality signals when evaluating food products. Specifically, interaction WTPs ( $\Delta WTP$ ) are interpreted as observable proxies of the extent to which labels convey complementary, or substitutable information (Gracia et al., 2014; Meas et al., 2015; Grebitus et al., 2018). Negative and statistically significant  $\Delta WTP$  values indicate sub-additive effects, reflecting informational overlap or substitution between signals. Interaction effects not statistically different from zero indicate approximately additive effects, consistent with dimensional orthogonality. Positive and statistically significant  $\Delta WTP$  values indicate super-additive effects, suggesting complementarity between labels.

By modelling these interaction effects, we move beyond the analysis of isolated label impacts and directly assess whether the Green-Score operates as a reinforcing signal that complements established certifications or, instead, acts as a competing signal that partially substitutes for them.

Lastly, to address potential heterogeneity in treatment effects, we estimated Latent Class Models (LCMs). The LCM framework relaxes the assumption of preference homogeneity across respondents by allowing for a finite number of unobserved segments (classes). Each class represents a group of consumers characterized by homogeneous preferences within the class but heterogeneous across classes (Greene & Hensher, 2003; Piracci et al., 2022). In our specification, the probability that an individual in class  $c$  chooses alternative  $j$  from choice set  $t$  is defined as:

$$P_{jc} = \frac{\exp(\beta'_c X_{jt})}{\sum_{i=1}^J \exp(\beta'_c X_{it})}$$

where  $c = 1 \dots, C$  denotes the latent class,  $\beta'_c$  are class-specific coefficients associated to class  $c$ ;  $X_{jt}$  is the vector of product attributes of alternative  $j$  in choice set  $t$ ; and  $J_t$  is the set of available alternatives. The probability of individual  $i$  belonging to class  $c$  is modelled as a function of socio-

demographic variables, attitudinal factors, and consumption habits (membership model). By including interactions between the salience nudge and the product attributes (Green-Score A+, Green-Score C, Organic, PDO), we test whether the treatment generates heterogeneous effects across consumer segments and whether these effects vary with individual characteristics (see Appendix D).

The number of classes was selected based on the Akaike Information Criterion (AIC), the Bayesian Information Criterion (BIC), and the interpretability of the solutions. (Califano et al., 2024; Areal & Asioli, 2023).

## 4. Results

### 4.1. Descriptive statistics

Attitudinal and socio-demographic characteristics of the 1102 Italian respondents are provided in Table E1 and E2 of the Appendix E. Participants ranged in age from 22 to 85 years, with an average age of 42. The majority were women (64.6%) and reported a comfortable financial situation (61.5%). A total of 424 of 1102 participants had completed a university degree, while the remaining 61.3% had a non-university level of education. As previously noted, the sample was divided into two subsamples to isolate the effect of the nudge.

To ensure comparability, we tested for differences in sociodemographic characteristics between the two groups. Several nonparametric Mann–Whitney tests were applied for income, education, household size and area of residence. A pairwise  $t$ -test was used for age, while a chi-square test was applied for sex at birth. The p-values reported in Table E2 (Appendix E) indicate no statistically significant differences between the two groups, suggesting that random assignment effectively balanced the subgroups in terms of age, gender, income, education, household size, and geographical area. Furthermore, as illustrated in Fig. F1 (Appendix F), self-reported ANA values are largely concentrated around the midpoint. Notably, the distributions of the attributes

included in the DCE are slightly skewed toward higher values, suggesting that respondents generally took all attributes into account when making their choices.

4.2. Effect of the Green-Score on consumers' WTP per specific food product category

To address the hypotheses H1 and H2, we estimated six mixed logit models in WTP space, one for each product (wine, EVOO, and buffalo mozzarella) under both conditions (control Vs. treatment). The results are presented in Table 2, which reports the mWTP values for the Green-Score A+, Green-Score C, organic, and PDO certifications, along with standard errors, significance levels, and model fit statistics. The no-buy option is significant and negative, indicating that respondents preferred one of the two product alternatives over the opt-out option.

Overall, PDO consistently commanded the highest WTP across all three product categories (€6.29 for wine, €10.89 for EVOO, and €4.17 for buffalo mozzarella), likely reflecting its strong institutional credibility and symbolic value.

The Green-Score A+ label was also highly valued, with mWTPs comparable to or exceeding those of organic certification: €5.20 versus €4.33 for wine, €8.13 versus €7.52 for EVOO, and €3.22 versus €2.92 for buffalo mozzarella. Even the Green-Score C rating, indicating moderate environmental performance, yielded positive and statistically significant mWTPs (€3.65 for wine; €5.28 for EVOO; €2.66 for buffalo mozzarella), suggesting that consumers are particularly sensitive to low environmental performance and are willing to reward higher sustainability levels without fully penalizing intermediate ratings.

Across wine and EVOO, the ranking of labels in terms of mWTP followed a clear pattern: PDO received the highest WTP, followed by Green-Score A+, organic, and Green-Score C. In buffalo mozzarella, all three labels were positively valued, though the ranking differed slightly, with organic certification carrying relatively greater weight—potentially due to its association with animal welfare considerations.

These results illustrate that PDO, organic certification, and Green-Score each function as relevant quality signals, shaping consumer preferences in complementary ways. The positive reception of the Green-Score A+ label indicates that it integrates well within the existing labelling landscape, complementing and reinforcing established signals. Taken together, these findings provide partial support for H1: while PDO remains the most valued certification due to its credibility, the Green-Score demonstrates strong diagnostic value and can outperform organic certification in specific contexts.

Supporting H2, pairwise comparisons (Appendix H, Table H1) show that WTP for the Green-Score A+ label was significantly higher for EVOO than for wine (p < 0.01), and significantly lower for buffalo mozzarella compared to both EVOO and wine (p < 0.01). A similar pattern emerged for Green-Score C, with mWTP highest for EVOO,

followed by wine, and lowest for buffalo mozzarella. These results indicate that the effectiveness of the Green-Score label is context-dependent: consumer valuation varies systematically across product categories, reflecting differences in category-specific decision contexts and the salience of relevant quality and sustainability attributes.

4.3. Nudge treatment effect

The results in Table 3 indicate that the salience nudge had a generally positive impact on consumers' mWTP for the Green-Score labels across all products. In particular, the mWTP for Green-Score A+ increased significantly for EVOO (+€2.75), wine (+€0.63), and buffalo mozzarella (+€0.25). Similarly, the mWTP for Green-Score C also rose across all products, most notably for EVOO (+€1.03) and wine (+€0.87), suggesting that even labels indicating moderate environmental performance gained decision weight when environmental information was made salient.

By contrast, the impact of the salience nudge on organic certification was more heterogeneous and product-specific. The treatment had no significant effect on wine, slightly reduced mWTP for EVOO, and increased mWTP for buffalo mozzarella (+€0.49). This pattern is consistent with a "goal-signal alignment" interpretation; i.e., when the Green-Score was made more salient, consumers may have partially shifted attention toward the new, highly diagnostic environmental information, reducing the marginal contribution of organic certification in some categories. For buffalo mozzarella, however, organic certification likely retained relevance due to its alignment with animal welfare considerations.

The PDO label showed consistently positive responses across all products, with mWTP increases under the treatment (e.g., +€1.10 for EVOO), likely reflecting its role as a credible and stable quality signal, relatively orthogonal to the environmental information conveyed by the Green-Score.

Overall, the salience nudge enhanced the perceived importance of the emerging Green-Score label, particularly for high environmental ratings, while modulating how consumers integrate overlapping or complementary cues.

To ensure that these effects reflect true preference shifts rather than changes in the scale of the error term, we estimated a Generalized Multinomial Logit (GMNL) model in WTP space (Fiebig et al., 2010; Gu et al., 2013), allowing for heterogeneity in both scale and preferences. The GMNL results, reported in Appendix L, confirm that the main findings are robust and not driven by scale heterogeneity.

Fig. 3 illustrates the distribution of individual-specific mWTP for the three sustainability labels across products, comparing control and treatment groups. For Green-Score A+ (top row), the treatment group generally exhibits higher mWTP than the control, particularly for EVOO (central panel), where the distribution shifts markedly to the right,

Table 2 Mixed logit model results in WTP space.

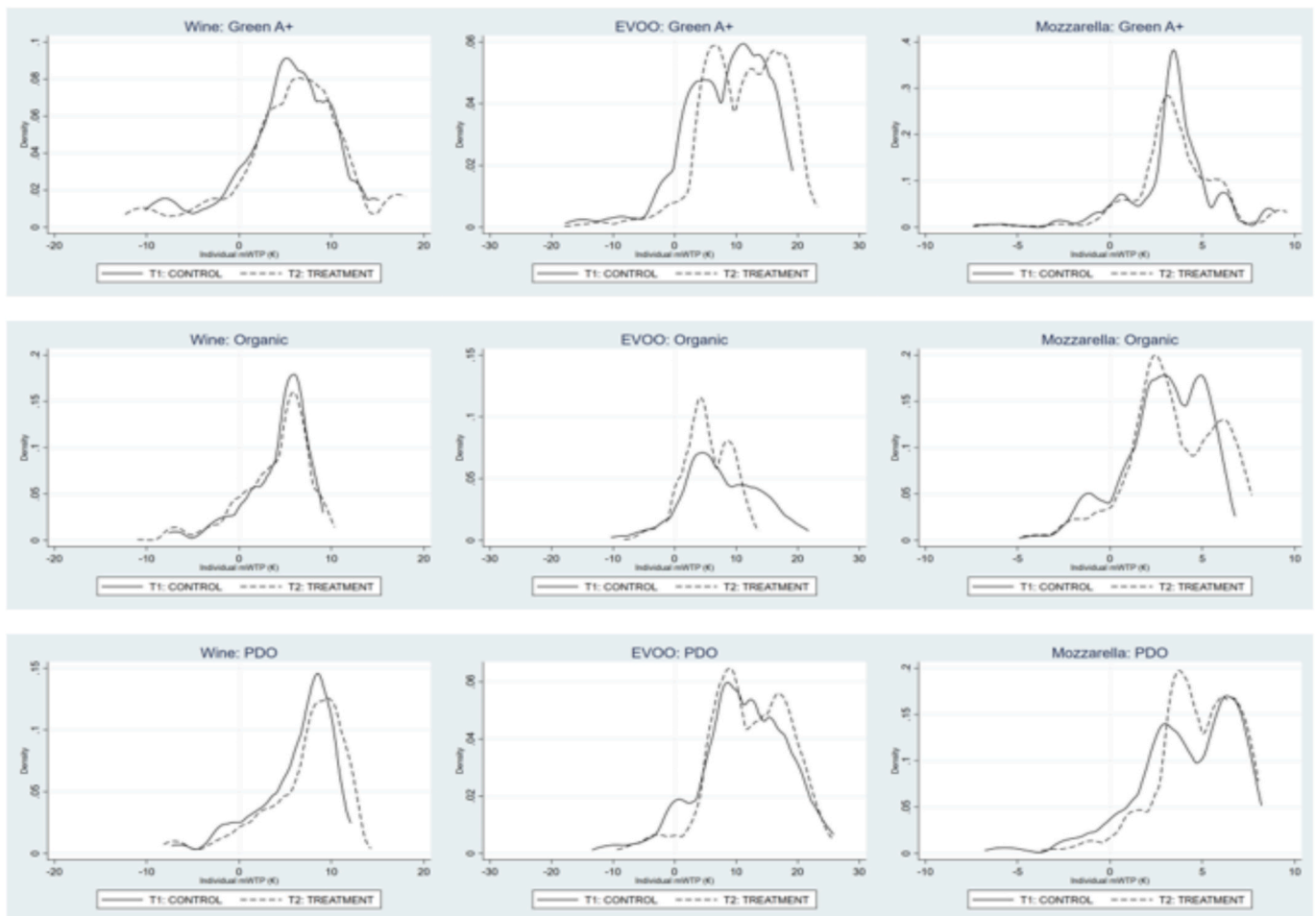
Attribute	Wine		EVOO		Buffalo Mozzarella	
	Control	Treatment	Control	Treatment	Control	Treatment
Green-Score A+	5.20***(0.808)	5.67***(0.464)	8.13***(0.598)	11.29***(0.734)	3.32***(0.230)	3.62***(0.103)
Green-Score C	3.65***(0.686)	4.38***(0.389)	5.28***(0.483)	6.57***(0.594)	2.66***(0.533)	3.23***(0.309)
Organic	4.33***(0.671)	3.88***(0.681)	7.52***(0.775)	5.27***(0.680)	2.92***(0.539)	3.42***(0.296)
PDO	6.29***(0.767)	7.00***(0.638)	10.89***(0.997)	12.37***(0.881)	4.17***(0.725)	4.73***(0.312)
Price	-1.76***(0.134)	-1.31***(0.119)	-1.90***(0.111)	-1.83***(0.115)	-1.22***(0.215)	-1.07***(0.118)
No Buy	-12.40***(0.864)	-12.44***(0.599)	-18.20***(1.073)	-16.84***(0.625)	-10.84***(0.664)	-9.27***(0.184)
Model Fit Statistics						
Wald chi2	347.87	780.49	605.09	1002.88	924.65	3499.03
Prob > chi2	0.000	0.000	0.000	0.000	0.000	0.000
Log Likelihood	-2615.7397	-2517.9115	-2452.1315	-2376.2228	-2522.5939	-2516.5761
AIC	5273.479	5077.823	4938.263	4794.446	5087.188	5071.152
BIC	5424.339	5229.445	5060.388	4946.067	5238.047	5208.334
Obs.	9738	10,098	9738	10,098	9738	10,098

Note: Standard errors in parentheses. <sup>1</sup> Number of observations (choice tasks for all respondents). \*\*\*, \*\*, \* refer respectively to 1%, 5% and 10% significant.

**Table 3**  
Differences in individual-specific WTP across conditions.

Variable	Wine	P-value <sup>1</sup>	WTP (%) <sup>2</sup>	EVOO	P-value <sup>1</sup>	WTP (%) <sup>2</sup>	B. Mozzarella	P-value <sup>1</sup>	WTP (%) <sup>2</sup>
Green Score A+	0.630 [-0.017; 1.278]	0.062	6.70%	2.748 [1.979; 3.518]	0.000	24.42%	0.253 [-0.020; 0.527]	0.060	3.85%
Green Score C	0.872 [0.260; 1.484]	0.008	9.28%	1.032 [0.543; 1.522]	0.000	9.17%	0.531 [0.272; 0.790]	0.000	8.08%
Organic	-0.291[-0.706; 0.123]	0.178	3.09%	-2.493 [-3.099; -1.888]	0.000	22.16%	0.493 [0.231; 0.754]	0.000	7.50%
PDO	0.900 [0.410; 1.390]	0.002	9.57%	1.104 [0.324; 1.884]	0.012	9.81%	0.562 [0.284; 0.840]	0.000	8.55%

Note: Confidence intervals in brackets are based on 1,000 bootstrap replications. <sup>1</sup>Two sided Poe- test from [Poe et al., \(2005\)](#). <sup>2</sup>WTP as % of average price.



**Fig. 3.** Individual specific mWTPs.

indicating a clear nudge effect. Wine (left panel) and buffalo mozzarella (right panel) show more concentrated distributions, suggesting stable preferences with smaller treatment-induced shifts. In EVOO, the treatment distribution appears bimodal, reflecting two consumer segments: one with moderate WTP ( $\pm\epsilon 2-10$ ) and another with higher WTP (above  $\epsilon 10$ ), consistent with heterogeneous responsiveness to salient environmental information.

For organic certification (middle row), treatment effects are more variable. EVOO and wine show little change, with a slight decrease in mWTP for EVOO, while buffalo mozzarella exhibits a rightward shift, indicating increased valuation, likely reflecting the association between organic certification and animal welfare.

For PDO (bottom row), preferences remain strong and stable across products. The treatment group shows slight increases in mWTP, particularly for EVOO and buffalo mozzarella, though these shifts are

less pronounced than for the Green-Score, consistent with PDO's role as a credible but less diagnostic signal with respect to environmental performance.

Table 4 reports the interaction WTPs ( $\Delta$ WTP) between Green-Score levels and the established labels organic certification and PDO, by product category and experimental condition (full estimates are reported in Appendix G). Following [Gracia et al. \(2014\)](#), [Meas et al. \(2015\)](#) and [Greibitus et al. \(2018\)](#), negative and statistically significant  $\Delta$ WTP values indicate sub-additive effects, reflecting informational overlap or substitution between signals, whereas positive and significant values indicate super-additive effects and complementarity.

Two robust patterns emerge across product categories. First, interactions between the Green-Score and organic certification are predominantly negative, indicating substantial informational overlap between the two sustainability-related signals. This overlap is

**Table 4**  
Interaction WTPs ( $\Delta WTP$ ) between Green-Score and established labels (Organic, PDO), by product and treatment.

Interaction ( $\Delta WTP$ )	Wine Control	Wine Treatment	EVOO Control	EVOO Treatment	Buffalo Mozzarella Control	Buffalo Mozzarella Treatment
Green Score A+ * Organic	-5.984*** (1.003)	-0.005 (1.161)	-3.965*** (1.088)	0.481 (2.603)	-3.360*** (0.752)	-1.511 (0.985)
Green Score A+ * PDO	1.313 (0.982)	4.287*** (1.212)	2.172** (0.939)	8.321*** (1.085)	0.723 (0.769)	1.832** (0.888)
Green Score C * Organic	-5.945*** (0.923)	-3.069*** (1.175)	-8.530*** (1.322)	-5.627*** (1.516)	-3.805*** (0.963)	3.231*** (1.062)
Green Score C * PDO	1.561 (1.044)	1.352 (1.123)	7.956*** (1.423)	9.038*** (2.357)	2.674** (1.152)	4.492*** (1.133)

**Note:** \*\*\*, \*\*, \* refer respectively to 1%, 5% and 10% significant.

particularly pronounced for the mid-level Green-Score rating (C) and is consistently observed in wine and EVOO, as well as in buffalo mozzarella under the control condition.

Second, interactions between the Green-Score and PDO certification are generally positive, pointing to complementarity between environmental performance information and origin-based quality cues. This complementarity is especially evident for the Green-Score C level in EVOO and buffalo mozzarella and, in some cases, becomes stronger under the salience treatment, particularly for combinations involving the A+ rating.

Importantly, the salience nudge does not uniformly increase or decrease interaction effects but rather alters how multiple signals are combined at the point of choice. In particular, the nudge tends to attenuate the overlap between the Green-Score and organic certification in selected cases (e.g., the wine A+  $\times$  Organic interaction becomes statistically non-significant), while revealing or strengthening complementarities between the Green-Score and PDO. To further elucidate these mechanisms, we split the sample according to participants' level of environmental concern using a median split of the environmental concern variable (low concern: below the median; high concern: equal to or above the median). This variable serves as an externally grounded proxy for the salience of environmental information. The split-sample estimates (Appendix, Table G2) largely confirm the main patterns.

Specifically, the Green-Score  $\times$  Organic interactions are predominantly negative and often statistically significant among low-concerned consumers, particularly for wine and EVOO under the control condition and for buffalo mozzarella across conditions. By contrast, the Green-Score  $\times$  PDO interactions are more frequently positive and statistically significant among high-concerned consumers, especially for EVOO.

For instance, under the control condition, both the Green-Score A+  $\times$  Organic and the Green-Score C  $\times$  Organic terms are negative and statistically significant for wine and EVOO. Among high-concern consumers, however, the Green-Score  $\times$  PDO interactions tend to be positive and significant, particularly for EVOO: the Green-Score A+  $\times$  PDO term is significant under both control and treatment, while the Green-Score C  $\times$  PDO term becomes strongly positive and significant under treatment. A similar, albeit weaker, pattern is observed for wine under treatment, where the Green-Score A+  $\times$  Organic interaction turns positive among high-concern consumers and the Green-Score A+  $\times$  PDO term is also positive and statistically significant.

Overall, these findings suggest that the informational content of co-occurring labels depends on both product context and consumers' environmental concern, and that increased salience can further reinforce these differences.

#### 4.4. Heterogeneity in the treatment effect

To further examine the impact of salience nudge on individual WTP, we also examined if there is heterogeneity in treatment effects across different groups of consumers. As highlighted by De Cianni et al. (2024), behavioural interventions may yield varying outcomes depending on the characteristics of the individuals exposed to the treatment. This underscores the importance of considering moderating factors, such as

income, education, age, and psychological or attitudinal traits, that may influence the efficacy of nudges and contribute to differential impacts across subgroups.

Table 5 presents the results of the LCM. The Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) used for model selection are reported in Table D1 (Appendix). As done by Areal and Asioli (2023), although AIC and BIC continued to improve beyond six classes, we chose the six-class model to balance statistical fit and interpretability.

Table 5 presents the results of the LCM. The Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) used for model selection are reported in Table D1 (Appendix).

As mentioned earlier, the goal of the analysis is to assess the heterogeneity in the effectiveness of an environmental salience nudge. This is done by including interaction terms between the treatment and various environmental labels (Green Score A+, Organic, and PDO). The findings reveal that the impact of the nudge differs substantially across classes.

Class 5 shows a strong positive response to the treatment, with significant and sizable interaction effects (the interaction between Green Score A+ and the nudge yields a coefficient of 2.557\*, while Organic  $\times$  Nudge reaches 1.084\*). These results suggest that this group is particularly responsive to environmental cues when they are made more salient. In contrast, Class 2 exhibits negative and significant interaction effects, (Organic  $\times$  Nudge = -2.400\*\* and PDO  $\times$  Nudge = -0.987\*\*), indicating a potential backlash effect or lack of engagement with environmental messaging.

Socio-demographic and attitudinal characteristics help explain class membership, with coefficients interpreted relative to Class 6, which serves as the reference category. Older individuals are more likely to belong to Class 1 ( $\beta = 0.019^*$ ), while men are overrepresented in Class 2 ( $\beta = 0.478$ ), which is less sensitive to environmental labels. Class 4 more frequently includes medium-to-high-income individuals ( $\beta = 0.458^*$ ), who tend to prefer sustainable products even in the absence of the nudge treatment. Interestingly, regular buyers of organic products are significantly underrepresented in Class 5 ( $\beta = -0.706^*$ ), suggesting that the nudge may be particularly effective among those who have not yet internalized sustainable habits.

The GHI variable is positively associated with membership in Classes 2 through 5 indicating that health awareness may serve as a cross-cutting driver of consumer choice, even among segments that vary in their environmental responsiveness.

Finally, environmental concern is negatively associated with membership in all classes compared to Class 6. This pattern suggests that Class 6 includes consumers who are already intrinsically motivated and thus less susceptible to behavioral interventions. Consequently, this group appears less responsive to the salience nudge, likely because environmentally friendly behavior is already part of their established decision-making process. In contrast, individuals with lower levels of environmental concern (more prevalent in Classes 2 and 5) are more susceptible to the treatment, indicating that nudges are more effective among less environmentally engaged consumers.

**Table 5**  
Latent class analysis (class 6 – reference group).

	Class 1	Class 2	Class 3	Class 4	Class 5	Class 6
Green Score A+	0.719***	−0.009	1.028***	2.667***	−0.493***	−0.146**
Green Score C	0.324***	0.352	0.429***	1.369***	−0.440***	−0.122*
Organic	−0.290***	2.241***	0.802***	1.094***	0.246***	0.254***
PDO	−0.442***	0.986***	1.754***	1.547***	0.302***	0.034
Price	−0.208***	−0.089***	−0.296***	−0.231***	−0.027**	−0.05***
No buy	−4.980***	−0.852**	−5.293***	0.979***	0.492***	−3.520***
Green Score A+ * Salience Nudge	0.081	−0.678	−0.245	−0.166	2.557***	1.016***
Green Score C * Salience Nudge	0.134	−1.174***	−0.322*	0.249	2.010***	0.474***
Organic * Salience Nudge	−0.057	−2.400***	0.031	−0.065	1.084***	−0.451***
PDO * Salience Nudge	0.202*	−0.987***	−0.356***	−0.295**	2.544***	−0.169*
<i>Membership</i>						
Age	0.019*	−0.003	−0.008	0.004	−0.002	/
Sex (1 if male)	0.446	0.478*	0.179	0.204	0.386	/
Education (1 if graduated)	0.385	−0.227	0.037	−0.265	0.023	/
Income (1 if middle-upper)	0.088	0.053	0.224	0.458*	0.013	/
Geographic Area (1 if North)	−0.249	−0.185	0.1	0.001	−0.206	/
Regular organic buyer (1 = yes)	−0.394	−0.32	−0.481**	−0.308	−0.706***	/
Social Norm	0.227	−0.227	−0.219	−0.201	−0.105	/
GHI	0.4	0.833***	1.121***	1.559***	1.147***	/
Environmental concern	−0.921***	−0.359	−0.417**	−0.481**	−0.426**	/
Constant	−1.486**	−0.372	0.393	−0.473	−0.056	/
Class Size	0.086	0.1	0.294	0.166	0.141	0.213

## 5. Discussion

This study examined Italian consumers' willingness to pay (WTP) for the emerging Green-Score sustainability label relative to two well-established certifications, organic and PDO, across three food categories: hedonic/experiential (wine), plant-based (extra virgin olive oil, EVOO), and animal-based products (buffalo mozzarella). The results illuminate how credibility, diagnosticity, product category, and salience interact to shape label valuation.

PDO consistently elicited the highest WTP, reflecting its strong institutional credibility, symbolic value, and association with provenance, sensory quality, and regional identity (Garavaglia & Mariani, 2017; Scarpa et al., 2007). The Green-Score generally outperformed organic certification but remained below PDO, partially confirming H1. This pattern highlights the trade-off between credibility and diagnosticity: while PDO benefits from established recognition and symbolic capital, the Green-Score's graded and visually intuitive format enhances diagnosticity, facilitating cross-product comparisons and clearer interpretation of environmental performance (De Bauw et al., 2022; Arrazat et al., 2023). It is possible that organic certification, although credible, could signal diffuse sustainability benefits and may function as a baseline cue, limiting its marginal impact.

Valuation varied systematically across product categories, supporting H2. For EVOO, the Green-Score generated the highest WTP, suggesting that diagnostic labels are especially valuable in categories with less tangible quality cues (Vecchio et al., 2021). In wine, PDO's symbolic and origin-based attributes dominated, with the Green-Score complementing PDO while partially substituting for organic certification. In buffalo mozzarella, consumers integrated PDO, organic certification, and Green-Score without substantial overlap, consistent with distinct informational content and the multifaceted ethical and environmental considerations of animal-based products (Clark et al., 2017; Stiletto & Trestini, 2022). These findings underscore product category as a key boundary condition for sustainability signalling (Spence, 1973; Mauri et al., 2021).

Salience nudges further clarified label effectiveness, supporting H3. By making environmental performance more salient, the nudge increased WTP for the Green-Score, reinforced complementarity with PDO, and reduced overlap with organic certification where signals conveyed similar information. This aligns with a goal-signal alignment mechanism: salient diagnostic cues gain decision weight, enabling consumers to interpret multiple signals coherently (Bordalo et al., 2013;

Sonntag et al., 2023). Overlapping labels (Green-Score × Organic) showed limited gains (sub-additive effects), whereas distinct signals (Green-Score × PDO) reinforced each other (super-additive effects), reducing uncertainty and increasing perceived coherence (Spence, 1973).

The nudge's effect was moderated by product category and consumer characteristics. In wine, entrenched heuristics around terroir and PDO constrained the impact, with complementarity emerging mainly for high-performing Green-Score ratings. In buffalo mozzarella, the nudge facilitated signal differentiation, enabling effective integration of sustainability and quality/origin information. Younger and higher-income participants were more responsive, whereas older consumers exhibited more stable preferences, highlighting heterogeneous nudge effects across demographic groups (Pandey et al., 2023; Sapio et al., 2025).

Interactions between labels further clarify how consumers combine signals. PDO and Green-Score, addressing distinct dimensions such as provenance/quality versus measured environmental performance exhibited complementarity. By contrast, Green-Score and organic certification partially overlapped, especially at mid-level Green-Score ratings, producing sub-additive effects in EVOO and wine. The nudge amplified the influence of diagnostic labels like Green-Score, strengthening synergy with PDO while mitigating redundancy with organic certification. In buffalo mozzarella, the nudge even transformed potential overlap into complementary effects, reflecting consumers' ability to integrate multiple, non-redundant signals when environmental goals are salient (Bordalo et al., 2013; Sonntag et al., 2023). Further insights emerge when accounting for heterogeneity in environmental concern. The split-sample analysis shows that the interpretation of co-occurring labels varies systematically with consumers' environmental predispositions.

Finally, the nudge also increased WTP for PDO, suggesting positive spillover effects. Environmental information can enhance the perceived relevance of origin-based attributes, consistent with partial goal congruence where provenance acts as a proxy for sustainability (Avetisyan et al., 2014). Regular organic food consumers maintained high WTP for PDO and organic certification, reflecting entrenched habits and strong ties to tradition and quality (Delmas & Lessem, 2017; Aprile et al., 2012; Mascarello et al., 2015).

## 6. Policy implications

By comparing Italian consumers' WTP for the emerging Green-Score

label against two well-established European certifications, organic and PDO, across three distinct food categories (wine, extra virgin olive oil, and buffalo mozzarella), the findings offer insights into consumer responses to sustainability information that may inform labelling policy and related policy design in contexts with similar market characteristics.

First, the results highlight the potential relevance of simplified, standardized environmental communication tools such as the Green-Score in encouraging consumers to make more sustainable choices. The fact that the label generated a higher mWTP than the organic certification, particularly for EVOO, suggests that concise and visually intuitive representations of environmental performance may reduce information asymmetries and cognitive costs at the point of purchase. From a policy perspective, this implies potential consumer surplus gains, especially in product categories where sustainability and quality attributes are difficult to assess through sensory cues alone. Consistent with prior evidence, such designs may facilitate rapid comparisons and more efficient decision-making (Rizzo et al., 2025; Edenbrandt and Lagerkvist, 2021). Nevertheless, these effects should be interpreted cautiously and are likely to be most applicable in Italy or in markets with similar familiarity with traditional certifications.

At the same time, the study underscores the continuing symbolic and cultural importance of traditional certifications, notably PDO, in shaping consumer preferences in Italy. The strong consumer preference for PDO-labelled products, even in the presence of the Green-Score, reflects the embedded value of tradition, regional identity, and sensory expectations. Importantly, these preferences could translate into substantial consumer surplus associated with origin-based labels. Indeed, consumers showed an additional premium price of 2.17€ when the Green-Score label complements PDO certification especially for EVOO. Thus, policies that position environmental labels as substitutes for PDO risk eroding this surplus. Instead, the findings support an integrative labelling strategy, in which environmental information complements rather than replaces established origin-based schemes, preserving cultural value while enabling additional sustainability-related differentiation.

Furthermore, the behavioural intervention employed in this study, a short, emotionally engaging video to enhance label salience, illustrates how low-cost information design tools can amplify the effectiveness of sustainability and origin labels. Specifically, the treatment information produced higher additional premium prices of 4.29€ for wine, 8.32€ for EVOO and 1.83€ for buffalo mozzarella, when Green-Score and PDO labels are both present in the same product.

Considering the Italian population of 50.2 million adult consumers (ISTAT 2026), a simple back-of-the-envelope calculation suggests that the increase in WTP induced by the video-based nudge may translate into substantial aggregate welfare gains. Focusing on EVOO, where the Green-Score and PDO labels exhibit a super-additive effect, the estimated additional premium of €8.32 translates into an increase in consumer surplus of approximately €417 million per purchase occasion. Extending the same back-of-the-envelope calculation to wine and buffalo mozzarella yields additional welfare gains of approximately €215 million and €92 million, respectively, resulting in an overall indicative welfare increase of about €725 million across the three product categories. These figures should be interpreted as indicative estimates, as they assume one purchase per consumer and do not account for substitution patterns across products and consumption heterogeneity.

The results also suggest that the effectiveness of labelling policies critically depends on salience and informational design. However, the positive spill-over effects observed for PDO also indicate that such nudges may activate heuristics linking local origin with sustainability, which could distort consumer beliefs if not carefully designed. Policy-makers should therefore ensure that behavioural interventions are aligned with accurate and transparent information.

The observed variation in consumer responses across product categories further reinforces the need for context-specific policy design. For products like EVOO, standardized environmental labels appear

particularly informative and welfare-enhancing, while for animal-based products like buffalo mozzarella, consumers seem to perceive Green-Score, organic, and PDO labels as complementary, conveying distinct but mutually reinforcing information on environmental, ethical, and origin-related attributes. This suggests that uniform labelling policies may be inefficient, and that product-specific implementation can improve both informational effectiveness and welfare outcomes.

The heterogeneity in the treatment effect across socio-demographic groups has important distributional implications. Younger and higher-income consumers appear more receptive to new sustainability information, while lower-income consumers or habitual buyers of organic products benefit less and may be more exposed to potential price increases if implementation costs are passed on. To avoid potential regressive effects, sustainability labelling policies may need to be complemented by targeted communication strategies, simplified messaging, or measures that improve affordability and access to sustainable products.

Beyond consumer behaviour, the estimated WTP values also imply potential effects on producer pricing strategies and welfare distribution. From an implementation perspective, the adoption of the Green-Score entails predominantly fixed costs related to data collection, score computation, and potential verification procedures. Evidence from existing environmental labelling schemes indicates substantial variability in unit costs, ranging from a few hundred euros to approximately €20,000 per product, depending on the number of product references, data availability, and implementation complexity (Ernst & Young, 2013). However, firms applying labelling across a large number of product references—typically more than 50 references—report unit costs converging towards a few hundred euros per reference, reflecting significant economies of scale (François-Lecompte et al., 2017). Marginal labelling costs are negligible, while additional adjustment costs may arise from production or sourcing changes and are likely to vary across firms. While these costs remain relatively limited for larger firms, they may represent a non-trivial burden for smaller producers, thereby generating asymmetric adoption incentives.

When compared with the magnitude of the estimated WTP premiums, these implementation costs could appear broadly compatible with positive net welfare effects, at least under conditions of effective consumer uptake and attention (Sunstein, 2021). Thus, producers achieving higher environmental performance scores may be able to partially appropriate consumer surplus through price premiums, while producers facing higher compliance or adaptation costs, particularly small-scale, may experience margin pressure.

This highlights the importance of accompanying sustainability labelling policies with support mechanisms, such as voluntary or phased adoption schemes, technical assistance, or targeted financial incentives, to mitigate adjustment costs and avoid uneven welfare effects or market exclusion.

Overall, while the study provides exploratory evidence that harmonized sustainability labels may enhance welfare and support more sustainable consumption, their policy implementation should be approached cautiously. Effectiveness is likely to depend on how new sustainability labels interact with established certifications and how consumers weigh credibility and diagnosticity in their purchase decisions. In markets such as Italy, where origin-based labels already convey strong cultural and symbolic signals, emerging labels may enhance welfare primarily when positioned as complementary rather than substitutive. Policy design should therefore be context-sensitive, gradually implemented, and accompanied by monitoring of consumer and producer impacts.

## 7. Conclusions and limitations

Notwithstanding the contributions of the study, there are some limitations that must be acknowledged. Firstly, the sample is limited to Italian consumers, whose strong regional food culture and familiarity

with traditional certifications may not be representative of broader or international consumer populations. To assess the generalisability of the findings, it would be advisable to replicate the study in different cultural and regulatory contexts.

Secondly, the experiment is based on stated preferences in a hypothetical setting. Despite the extensive utilisation of DCEs in approximating real-world behaviour, it is acknowledged that actual purchasing decisions may be influenced by factors not encompassed within this framework, including price promotions, habitual routines, and temporal constraints. The utilisation of complementary studies, encompassing experimental auctions, real market data, or field experiments, would serve to enhance the validation of the proposed model. Moreover, the DCE results may indicate that the influence of sustainability labels, particularly emerging labels such as the Green-Score, could be primarily short-term, as consumers might gradually habituate to these cues, reducing their perceived value and impact (Bastounis et al., 2021). Future research, including longitudinal or field-based studies, is needed to assess the durability of label effects over time. Furthermore, the heterogeneity analysis of treatment effects does not allow for an assessment of the distributional implications across consumer segments. As a result, future research could explicitly investigate how welfare effects vary across different consumer groups, thereby providing a more nuanced understanding of potential equity and distributional consequences. Thirdly, the Green-Score label is currently based on an incomplete LCA, raising concerns about its transparency and scientific robustness. These limitations assume particular significance in the context of the European Union's proposed Directive on Green Claims (Directive EU 2024/825), which aims to prevent greenwashing by requiring that all environmental marketing claims be substantiated using harmonised and scientifically reliable methods, such as the PEF and OEF methodologies. Until then, labels such as the Green-Score may offer practical value to consumers but could be perceived as insufficiently rigorous or even misleading by more informed stakeholders.

In conclusion, the behavioural intervention demonstrated efficacy in the present study; however, it should be noted that its implementation occurred within the confines of a controlled experimental setting, utilising video stimuli as a medium. However, real-world deployment in retail contexts may encounter various challenges, including competing demands, external noise, and stakeholders' resistance. To enhance the practical relevance, salience nudge could be adapted for in-store displays, or digital shopping interfaces, where sustainability information can be made more salient at the moment of choice. Future research should further explore how such behavioural interventions can be scaled and integrated into actual retail or e-commerce environments, while also assessing their long-term effectiveness and potential interactions with other informational cues or marketing strategies.

[During the preparation of this work the authors used ChatGPT to improve readability. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.]

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## CRediT authorship contribution statement

**Francesco Vella:** Writing – original draft, Methodology, Formal analysis, Data curation. **Rodolfo M. Nayga:** Writing – review & editing, Validation, Supervision, Methodology, Conceptualization. **Riccardo Vecchio:** Writing – review & editing, Validation, Methodology, Investigation. **Wei Yang:** Validation, Methodology, Formal analysis, Data curation. **Giuseppina Rizzo:** Writing – original draft, Investigation, Writing – review & editing. **Giuseppina Migliore:** Writing – review &

editing, Writing – original draft, Validation, Project administration, Methodology, Investigation, Funding acquisition, Conceptualization.

## Appendices. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.foodpol.2026.103101>.

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