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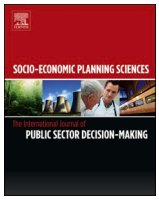

A new composite index to assess environmental consciousness using survey data and big data: Empirical evidence from European consumers

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ABSTRACT

Environmental consciousness is a multi-dimensional construct that encompasses several dimensions related to pro-environmental attitudes, beliefs and behaviours. The academic literature has attempted to conceptualise and operationalise environmental consciousness over the last 20 years, resulting in a wide variety of measures.

However, the available measures are country-specific and with a predominant U.S. focus, based on convenience samples, and rather limited in terms of interpretability and external validity. To overcome these limitations, the present study develops an index of environmental consciousness at both the micro (consumer) and macro (country) levels, taking into account the four main dimensions of environmental consciousness: the affective, cognitive, active and dispositional dimensions. By analysing more than 27 000 "Eurobarometer 92.4" responses from consumers in the 28 EU Member States in 2019, this paper develops a comprehensive measure of consumer environmental consciousness that captures the heterogeneity across European countries. To assess the robustness of the index, the link between environmental consciousness and life satisfaction is also examined. The index is also compared with a big data-based index using Google Trends data on environmental search categories. The results show differences in environmental consciousness between European countries. The link between environmental consciousness and life satisfaction is also supported, in line with previous research in this area. Finally, the index appears to be strongly correlated with actual consumer search patterns on Google. The findings have implications for businesses willing to enter in new markets and policy makers on how to measure and assess environmental consciousness.

1. Introduction

Population growth, industrial production processes and new consumption models have generated a wide range of environmental protection challenges [1]. Academic research has made available several tools and approaches to assess negative consequences on the environment (e.g. Ref. [2]). Despite these efforts, environmental issues are still unresolved. For instance, according to the latest European Environmental Agency estimates, at least 253 000 deaths in the EU in 2021 were attributable to air pollution [3]. Policymakers around the world are making efforts to promote sustainable behaviours among businesses and consumers, such as reducing energy consumption and greenhouse gas emissions, purchasing products or services that have a lower negative impact on the environment, and implementing waste recycling. More than 100 countries joined forces to sign international agreements to protect the environment, such as the Kyoto Protocol [4]. The European Commission's 2030 Climate Action Plan proposes to reduce greenhouse gas emissions to at least 55 % below 1990 levels by 2030 [5]. However, CO^2 emissions emitted abroad to satisfy EU consumption (so-called imported CO^1 emissions) grew by around 3.5 % in 2018 (Fig. 1), a faster rate than GDP [6]. Therefore, the effectiveness of the above commitments depends on consumers' attitudes towards the environment, which have been shown to be a strong driver of pro-environmental behaviour [7]. Managers also need to reduce their environmental impact and build a more efficient environmental management system and some approaches in the literature point in this direction (e.g., Ref. [8]).

Academic research on various aspects of pro-environmental attitudes has been focused and labelled around the concept of environmental consciousness [9]. Environmental consciousness can be seen as a psychological awareness of the need for pro-environmental action [10].

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[1] Maps for $\lambda = 0.25$, $\lambda = 0.50$ and $\lambda = 0.75$ are available upon request.

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Promoting environmental consciousness is also viewed as important by policy makers [11,12]. Indeed, as consumers develop their understanding of environmental issues, they may be more likely to engage in pro-environmental behaviour [13]. Environmental consciousness has been found to lead consumers to adopt behaviours that have a significant and positive impact on the environment [14]. Consumers are a very important part of the production-consumption chain, as their choices influence the sustainability practices of companies, thus becoming a driver for corporate and public action in implementing sustainability practices and green innovations [15]. Moreover, measuring environmental consciousness over time could be useful for policy makers to understand the current level of public awareness and to measure the effectiveness of their environmental promotion campaigns over time.

Despite the importance of environmental consciousness, there are several unresolved issues regarding its measurement. Over the last 40 years, the academic literature has conceptualized and operationalised environmental consciousness, resulting in a wide range of measures. However, the available measures are country-specific, and they have been developed with a predominant U.S. focus (Diamantopoulos et al. , 2003). Few studies have adopted an international focus, involving consumers from multiple countries, especially in the European context [16]. Current measures of environmental consciousness are mostly based on convenience samples that are unrepresentative of the total population: this entails limitations in terms of interpretability and external validity [9]. Cruz and Manata [17] highlight that studies on environmental consciousness should use nationally representative samples and that there are many old scales that are not suitable for measuring new environmental issues. Moreover, environmental consciousness cannot be measured by a single descriptive indicator but should be represented through multiple dimensions [9]. Therefore, a research gap emerges with reference to the development of an updated, comprehensive and representative measure of environmental consciousness.

Given the relevance of the topic and in light of the above-mentioned gaps, the present study proposes a composite indicator of environmental consciousness at both micro and country level, taking into account indicators of the four main dimensions of environmental consciousness identified by previous studies [7,18]: the affective, cognitive, active and dispositional dimensions.

The development of this composite indicator is based on more than 27 000 "Eurobarometer 92.4" (EB 92.4) responses collected from consumers in the 28 EU Member States. The developed indicator aims to be a comprehensive measure of consumer environmental consciousness enables heterogeneity at the country level to be captured in several countries. To assess the robustness of the index, the present work also examines the link between the developed composite indicator of environmental consciousness and life satisfaction. There is a growing stream of literature providing empirical evidence of the positive link between pro-environmental intentions and behaviours with life satisfaction (e.g., Ref. [19–21]). Therefore, the positive relationship between environmental consciousness and life satisfaction is further tested to confirm the robustness of the developed indicator. Finally, given that the environmental consciousness indicator has been developed based on the same data source employed to measure life satisfaction, the developed indicator is further validated by employing an additional data source, namely user search data on Google Trends at the country level. Specifically, the correlation between the developed indicator using survey data and Google Trends data on environmental-related searches in the same time frame is tested across countries. The goal is to assess whether there is a significant relationship between country scores of the composite indicator and the number of environmental-related searches in Google. Results from the analysis show a positive and significant relationship with life satisfaction and a positive and significant relationship between the composite indicator and environmental-related searches on Google Trends, thus offering support for the developed composite indicator.

The present study contributes to the stream of literature on environmental consciousness by providing a new robust indicator that considers its four key dimensions and it is developed with an international focus and validated with data stemming from another source.

Given the relevance of the phenomenon for both policy makers and citizens, a composite index certainly provides relevant benefits. First, on the empirical side we contribute to the stream of literature studying the awareness on environment related issues by enlarging the geographical scope. Second, a composite index can be easily disseminated to the public and immediately understood by the users [22]. Moreover, the present work also offers a contribution to the stream of literature on the relationship between pro-environmental behaviours and individual

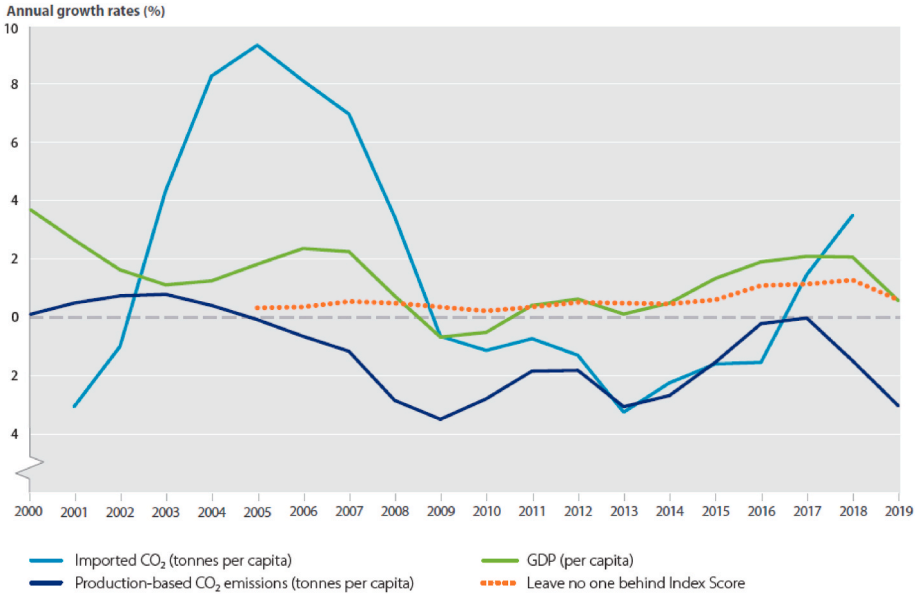

Fig. 1. Decoupling of socio-economic progress against environmental impacts, EU27, 2005–2019.
Note: Imported CO2 emissions refer to CO2 emissions emitted abroad (e.g. to produce cement or steel) to satisfy EU27 consumption of goods and services. Three-years moving averages.
Source: Sustainable Development Solutions Network (SDSN)

well-being by extending this link also to environmental consciousness. Finally, the composite indicator may have implications for policy makers and managers as it could be a useful tool to monitor the current state of environmental consciousness. Policymakers could use the indicator to monitor the environmental consciousness of citizens through an immediate understanding, to promote the improvement of the level of environmental consciousness worldwide and to assess the effectiveness of their policies. Businesses could use the indicator to analyse the extent to which their current or potential customers are environmentally aware, and to develop new products and services or new marketing activities aimed at their green customers.

The rest of this paper is organized as follows. First, a literature review on environmental consciousness and its previous measures is presented. Second, the conceptual development leading to the definition of the key dimensions of the proposed composite indicator is presented. Third, the methodology and results shed light on how the indicator is developed and tested to assess its robustness. The paper concludes with reflections on theoretical and practical implications, limitations and future research directions.

2. Literature review and theoretical background

2.1. Defining environmental consciousness and its measures

Defining environmental consciousness is a complex task, as the concept is based upon several components such as environmental knowledge, values, attitudes and emotional involvement, [23]. Environmental consciousness can be interpreted as a mental behaviour focused on the recognition of environmental issues [24,25]. It is a non-egoistic attitude that resembles the extent to which an individual feels concerned about the environment [26,27] and has been defined as the "psychological awareness of the need for pro-environmental action" ([10]:3). Awareness of environmental issues implies that individuals are informed and recognize key elements such as the current state of the environment, climate change and the ecological impact of consumption and production [28]. Environmental awareness among managers and stakeholders can also play a key role in corporate strategies. Environmental awareness among stakeholders is positively related to green product innovation and green process innovation [29]. Moreover, CEO environmental awareness promotes new product development performance and encourages employees to develop sustainable innovations [30].

Studies have largely focused on the relationship between environmental consciousness and consumer decision making. Eco-awareness is "associated with actions aimed at reducing the impact of human behaviour on the environment" [31]. It increases the willingness to seek information about green products and services [32] and promotes the choice of green transportation methods [33,34]. Individuals with a high level of environmental consciousness are more inclined to engage in various pro-environmental behaviour, such as accepting energy-saving policies, choosing ecologically responsible packaging, and green purchasing behaviours [35]. Awareness of current environmental issues also leads consumers to purchase products and services displaying a less negative impact on the environment [36–38]. For instance, green travel behaviour is driven by environmental consciousness, and this holds true especially for the Generation Z, namely individuals that were born between the middle of the 1990s and the start of the 2010s [39]. However, it should be noted that being highly environmentally aware may require significant behavioural changes that are difficult to implement, leading to the well-known "attitude-behaviour gap" [40]: individuals may be highly aware of environmental issues but still not change their behaviours and still act in ways that are harmful for the environment.

The various studies on the concept and measurement of environmental consciousness are largely based on psychological and sociological models, the theory of reasoned action, the theory of planned behaviour, the value-belief-norm model, and so on [7]. Typically, three aspects have been considered when measuring environmental consciousness: attitudes, behaviours and knowledge related to the environment [9]. When focusing on attitudes, refer to individuals' level of concern/interest in environmental areas. Pro-environmental behaviours are addressed by assessing individuals' past, present, and/or future commitment to actions aimed at reducing society's negative impact on the environment. Knowledge, instead, tends to be measured by assessing the level of factual information about aspects of the environment. Laheri et al. [41] employ the Theory of Planned Behaviour and develop a theoretical framework on environmental consciousness, conceptualized as a multidimensional concept related to three environmental factors such as environmental concern, environmental knowledge and environmental values. Their study shows that within the construct of environmental consciousness, environmental values play the most important role in explaining attitude towards purchasing green products, followed by environmental knowledge and environmental concern.

Given the relevance of environmental consciousness, numerous attempts throughout the years have been undertaken to define and develop an operationalization of the "environmental consciousness'' construct in a wide range of social science disciplines, such as psychology, sociology, environmental studies, business research, marketing, and so on [9]. Existing measures of the construct of environmental consciousness have largely addressed one or two of the above aspects, without adopting a comprehensive approach. According to Hawcroft and Milfont [42], despite the good number of environmental consciousness measures available, only three have been widely employed: the Ecology Scale [43], the Environmental Concern Scale [44] and the New Environmental Paradigm Scale (NEP) [45]. These three scales examine multiple elements of environmental consciousness, namely the above-mentioned areas such as attitudes, behavioural intentions/behaviours and concern/knowledge about various environmental topics. The Environmental Concern Scale and the Ecology Scale have been deemed outdated because they employ items that mention specific environmental topics or events that are not contemporary [26]. The NEP scale avoids the above issue because it employs more generic items and, for this reason, it has gained higher attention and favour among academics. It requires respondents to express agreement or disagreement on a scale with twelve statements. An example item is "The balance of nature is very delicate and easily upset". The NEP assumes that environmentalism is related to a general eco-centric point of view where humanity needs to find and keep a balance with nature. However, several issues have emerged with reference to studies adopting the NEP [42]: the use of non-representative samples, which could affect the measured level of environmental consciousness, the influence of even small variations in the wording of the NEP items on the accuracy of the research findings and the fact that the majority of studies using the NEP Scale have been conducted in North America. Few studies have adopted an international focus involving representative samples of consumers from multiple countries [16]. Table 1 summarizes relevant previous research and compares it with our study. Therefore, the present paper aims to address the above-mentioned gaps by proposing a new composite indicator based on the theoretical framework developed by Sanchez and Lafuente [18].

2.2. Research framework: environmental consciousness and its relationship with life satisfaction

As mentioned above, the present paper adopts the theoretical framework developed by Sanchez and Lafuente [18], which offers an operationalization of environmental consciousness based on the attitude structure theory [45,47]. The framework suggests that environmental consciousness can be explained by four dimensions defined in social psychological theories as the attitude structure: affective, cognitive, dispositional and active. The affective dimension of environmental consciousness captures the concern for the environment support for a pro-environmental global perspective on environmental issues and

Table 1
Summary of previous studies on Environmental Consciousness.

Study	Theoretical background of reference	Multidimensional construct of Environmental Consciousness (Yes vs. No)	Country	Type of sample (Convenience vs representative)	Method	Main conclusions
Maloney, Ward, and Braucht [43]	Ecological Psychology	Yes	United States	Convenience	Anova and post-hoc analysis	The study develops a shorter version of the four ecology subscales. The new scale has not only increased their practical efficiency (i.e., made them shorter) but has also generally improved them from a psychometric point of view, with the exception of slightly decreased reliability.
Weigel and Weigel [44]	Ecological Psychology	Yes	United States	Convenience	Correlation, reliability and validity analysis	An Envinronmental Concern Scale has been developed, displaying internal consistency, reliability and validity. The scale appears to be appropriate to measure correlated and determinants of attitudinal concern about environmental quality and longitudinal change in public attitude
Dunlap et al. [45]	Attitude Theory	No	United States	Convenience	Correlation, reliability and validity analysis	Results suggest that it is appropriate to treat the new set of 15 items designed to measure endorsement of an ecological worldview as constituting a single "New Ecological Paradigm Scale" (NEP scale). The revised NEP Scale provides a more comprehensive coverage of key facets of an ecological worldview, avoids the unfortunate lack of balance in item direction of the original scale and removes the outmoded terminology in some of the original scale's items.
Sanchez and Lafuente [18]	Centre-periphery theory + sociology and environmental psychology background	Yes	Spain	Representative (at a regional level)	Principal Component Analysis	The study has defined environmental consciousness as a multidimensional, behaviour-oriented concept and has proposed an operationalization which, on the basis of different theoretical explanations, integrates the psychological constructs of the dimensions that comprise it (affective, cognitive, dispositional and behavioural).
Golob and Kronegger [7]	Four-dimensional construct of environmental consciousness; Theory of planned behaviour	Yes	28 EU member states	Representative of each country out of 28 countries in Europe	Structural Equation Models and Hierarchical Clustering	A high proportion of the variance in responses to proenvironmental behaviour can be explained by affective, cognitive and dispositional attitudinal dimensions. The dimensions of the developed model effectively contribute to the segmentation of individuals: EU consumers cluster in three different segments, ranging from those who tend to be more environmentally conscious to those who exhibit lower levels of such consciousness. The results point to dissimilarities in environmental consciousness across the EU.
Fockaert et al. [46]	Social–ecological systems theories	Yes	Belgium	Convenience	Hybrid choice modeling	Results show that citizens do not only value aesthetics but also environmental and conservation efforts and outcomes. The study focused on the practices implemented by the farmers instead of overall landscape outcomes. In this respect farmers efforts are often appreciated. Interventions focusing on discussing attitudes and values may have significantly more potential.
Laheri et al. [41]	Theory of Planned Behaviour	Yes	India	Convenience	Structural Equation Models	Results indicate that environmental factors reflecting environmental consciousness positively influence consumers' attitude towards purchasing green products, wherein consumers' environmental values have

(*continued on next page*)

Table 1 (*continued*)

Study	Theoretical background of reference	Multidimensional construct of Environmental Consciousness (Yes vs. No)	Country	Type of sample (Convenience vs representative)	Method	Main conclusions
						a stronger influence than their environmental concern and environmental knowledge.
Our study	Sociology and environmental psychology background	Yes	28 EU member states	Representative of each country out of 28 countries in Europe	Principal Component Analysis and compensatory weighting	The results led to the development of an Environmental Consciousness Index, highlighting differences in environmental consciousness between European countries. The relationship between environmental consciousness and life satisfaction is also supported. Finally, the Environmental Consciousness Index appears to be strongly correlated with actual consumer search patterns related to environmental topics on Google.

reflects the extent to which individuals perceive the importance of environmental issues. The cognitive dimension is related to the amount of information and knowledge about environmental issues and to what extent the individual is aware of environmental issues and of its causes and consequences [48]. This dimension therefore highlights the role of education and knowledge. The dispositional dimension refers to the personal commitment and intention to take responsibility and bear personal costs when engaging in pro-environmental behaviour and following environmental policies. The active dimension refers to different pro-environmental behaviours: this dimension is more focused on the actual completion of certain behaviours. Recent studies have adopted this framework with different purposes. Golob and Kronegger [7] have tested the relationship between the four above-mentioned dimensions, and they have developed a segmentation approach based on the dimensions of environmental consciousness to identify segments of individuals. Sànchez-Llorens et al. [49] have used the four dimensions to compare the level of environmental consciousness of two different student populations from primary and secondary schools. Fockaert et al. [46] have adopted the framework of Sanchez and Lafuente [18] to explain citizens' preference and willingness to pay for those agri-environmental measures that can compensate farmers for unexpected costs or loss of income with public money, thus providing benefits to the society as a whole. By building on the framework of Sanchez and Lafuente [18], we develop a composite indicator that measures environmental consciousness at both the individual level and that of a country, thanks to the availability of Eurobarometer data on 'Attitudes of European Citizens towards the Environment'. To further test the robustness of our composite indicator and to enrich the contribution of the present work, we also explore the link between the composite indicator on environmental consciousness and life satisfaction, as suggested by previous literature.

Life satisfaction is usually employed as the operationalization of subjective well-being. In fact, the definition of subjective well-being (SWB) is broad and includes both affective and cognitive components [50]: well-being encompasses emotional responses, domain satisfactions, and global judgments of life satisfaction [51]. There is empirical evidence that pro-environmental intentions and behaviours are positively associated with life satisfaction. Both green purchasing intentions and green purchasing behaviours have been found to be associated with life satisfaction [20]. Kasser [52] highlighted that 13 different studies across multiple countries and tens of thousands of subjects show a consistent and significant positive correlation between engagement in pro-environmental behaviours and subjective well-being. Schmitt et al. [21] found that perceiving ecological threat drives pro-environmental behaviours, which in turn leads to positive effects on life satisfaction. Lin and Niu [53] found that consumers displaying a certain level of environmental awareness and concern are more likely to orient their purchasing behaviour towards environmental responsibility, which in turn leads to higher well-being.

As noted above, the dimensions of environmental consciousness identified by Sanchez and Lafuente [18] are related to information on the environment, perceived importance of environmental issues, perceived responsibility for the environmental status quo and willingness to undertake pro-environmental behaviours. Thus, they are consistent with those pro-environmental attitudes, intentions and behaviours that have been found to be positively linked with life satisfaction. Therefore, based on the above considerations, we would expect a positive and significant relationship between our composite indicator of environmental consciousness and life satisfaction.

3. Methodology

We use the dimensions of environmental consciousness described above to construct an indicator of the environmental consciousness of each European citizen-consumer. The composite indicator of environmental consciousness proposed here addresses environmental consciousness at the micro level in terms of all measurable dimensions and combines the information into an overall assessment of citizen-consumers' environmental consciousness.

We developed environmental consciousness indicator following a fairly well-established strand of literature that provides guidance on the construction of composite indicators, produced by the Organization for Economic Co-operation and Development (OECD) and the Joint Research Centre of the European Commission (JRC) [54]. The main factors to consider when constructing the composite indicator are: i) selection and normalization of indicators, ii) weighting of indicators and iii) aggregation of indicators.

There is no absolute best method for constructing a composite indicator (e.g., Ref. [55]), but often the choice falls on a mix of different elements depending on the phenomenon under study.

In the present work, the approach chosen is based on the distance to the ideal point measured by different degrees of compensability developed by Diaz-Balteiro and Romero [56], together with a Principal Component Analysis (PCA)-based strategy to compute weights.

Fig. 2 summarizes all implementation steps followed in the construction of the Environmental Consciousness Indicator (ECI) (see Fig. 3).

- *Indicator selection and Normalization*

For the selection of primary indicators, and within the limits of data availability, we followed Sanchez and Lafuente [18] who defined and

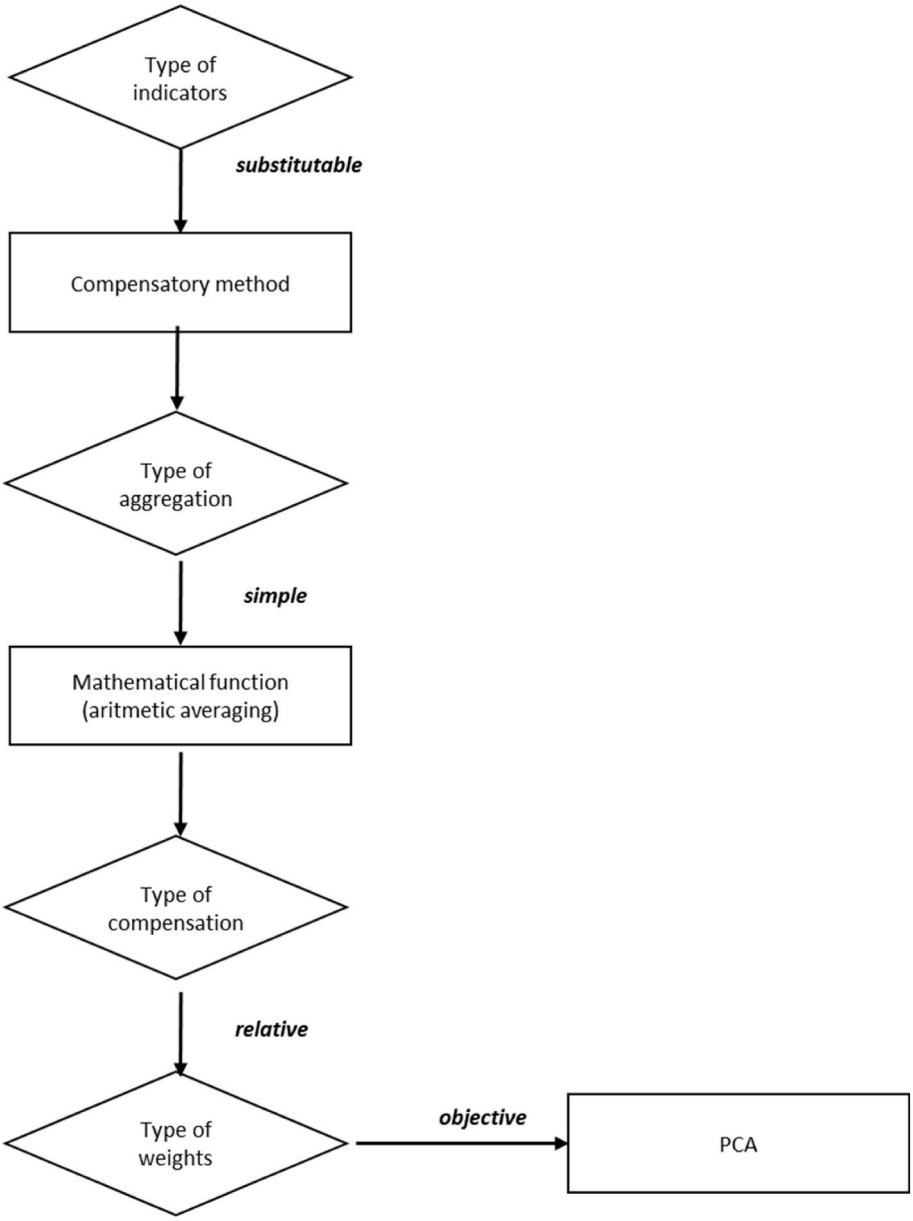

Fig. 2. The path of the 'Environmental Consciousness Index (ECI).

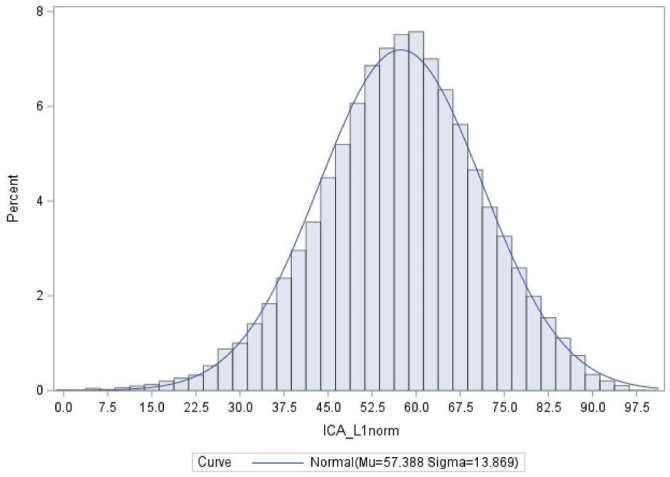

Fig. 3. Distribution of ECI ($\lambda = 1$).

operationalises environmental consciousness as covering four dimensions: affective, cognitive, dispositional and active. The variables were chosen to reflect different sub-domains of the same phenomenon.

Let us consider the sample of n elementary units (the EB respondents). Each respondent $i=1,2, \ldots,n$ is evaluated according to m primary indicators of environmental consciousness j, with $j=1,2, \ldots,m$.

We assume that the primary indicators are 'substitutable' (e.g., a low value for "worried about the environmental impact of everyday products made of plastic" can be offset by a high value for "worried about the impact of chemicals present in everyday products on your health").

The aim is to define a unique numerical indicator for each respondent as a composite of the m primary indicators that keep track of the degree of environmental consciousness. Thus, we define ECI_i as the composite index of environmental consciousness for the generic ith unit. The following notation is introduced: I_{ij} as the score assigned by the ith respondent to the jth indicator, $I = \left(I_{ij}\right)_{ij}$ as the nxm matrix of scores, w_j as the weight of relative importance attached to the jth indicator and obtained through a PCA-based strategy, I_j^* as the optimum value of the

*j*th indicator of environmental consciousness (ideal value),[2] I_{*j} as the worst score assigned (anti-ideal), $\bar{I}_{ij}$ as the normalized score assigned by the *i*th respondent to the *j*th indicator of environmental consciousness, $\bar{I} = (\bar{I}_{ij})_{ij}$ as the *nxm* matrix of normalized scores, *p* as the metric that is a real number belonging to the interval $[1, \infty)$.

The various indicators of environmental consciousness are usually measured on different scales and their absolute values can be very different. For this reason, the first step toward the construction of the composite indicator involved normalizing of the *m* indicators.

Following Diaz-Balteiro and Romero [56] we used the normalization procedure in (1), which is appropriate when the indicator takes on the meaning of '*more is better*':

$$\bar{I}_{ij} = 1 - \frac{I_j^* - I_{ij}}{I_{*j} - I_j^*} = \frac{I_{*j} - I_{ij}}{I_{*j} - I_j^*} \tag{1}$$

Using the normalization system in (1), the indicators of environmental consciousness have no dimension and are also bounded between 0 and 1. Hence, for this normalization system the ideal vector is as in (2):

$$\bar{I}^* = (1, \ldots, 1) \tag{2}$$

and the anti-ideal vector is as in (3):

$$\bar{I}_* = (0, \ldots, 0) \tag{3}$$

- *Weighting of indicators*

An 'objective' weighting is used by constructing weights using Principal component Analysis (PCA). When using PCA to construct weights, the standard procedure is to use the eigenvector associated with the first component to serve as the weight for the primary indicators [55,57]. However, this alone may not explain a sufficient part of the variance of the indicators, and therefore more components should be retained. Several scholars have considered the factor loadings of all retained factors (e.g., Ref. [58,59]) in order to retain a larger proportion of the variation in the original data, and we followed such a strand of literature. In particular, after retaining the principal components, the weights of the variables were assigned by multiplying the contribution of each *j*th primary indicator to the K most important components retained k – say L_{jk} – with their proportion of explained variance (λ_k) as in (4):

$$w_j = \sum_{j=1}^{m} \sum_{k=1}^{K} |L_{jk}| \cdot \lambda_k \tag{4}$$

with w_j as the weight of the *j*th primary indicator, L_{jk} as the loading value of the *j*th primary indicator on the principal component k, and λ_k as the proportion of the explained variance of the *k*th PC. Final weights were rescaled to sum up to one.

- *Aggregation of indicators*

After the normalization and weighting of the variables, the aggregation of the different indicators into a composite indicator that measures environmental consciousness as a whole is a crucial and complex problem. The most used aggregation method for substitutable primary indicators is the additive one, as its main advantage is the methodological transparency (e.g., Ref. [60]). In this work, following Diaz-Balteiro and Romero [56], the composite indicator of environmental consciousness– ECI_i- is established for each respondent by calculating the distance (in a general sense) between the normalized scores of each respondent and the ideal vector of indicators $\bar{I}^* = (1, \ldots, 1)$. Therefore, the smaller the distance, the better the aggregated index. This can be achieved by applying the aggregation as in (5) for each *i*th respondent:

$$ECI_i = \sum_{j=1}^{m} w_j^p (1 - \bar{I}_{ij})^p, \forall\, i \tag{5}$$

If we consider the complement of the distance between normalized scores and the ideal vector, then the composite index of environmental consciousness is obtained as in (6):

$$ECI_i = \sum_{j=1}^{m} w_j^p \bar{I}_{ij}^{\,p}, \forall\, i \tag{6}$$

Therefore, the respondent that maximizes the expression (6) is the 'most environmentally conscious' respondent.

For *p=1*, we obtain a linear additive aggregation method based on which the 'most environmentally conscious' respondent is the one that maximizes the weighted sum of the normalized indicators as in (7):

$$ECI_i = w_1 \bar{I}_{i1} + \ldots + w_m \bar{I}_{im} \tag{7}$$

Since the weighted additive system in (7) ignores interactions between variables [56] and implicitly assumes full compensability between indicators [61], following the more general framework developed by Biaz-Balteiro and Romero (2014) for the sustainability case, the environmental consciousness composite indicator is constructed as in (8):

$$ECI_i = (1 - \lambda)\left[\min_j (w_j \bar{I}_{ij})\right] + \lambda \sum_{j=1}^{m} w_j \bar{I}_{ij}, \forall\, i \tag{8}$$

By considering different values of λ in (0,1] it is possible to account for different degrees of compensability. We take into consideration two different situations: a) total compensability (λ = 1) and b) different degrees of partial compensability (λ = 0.25, λ = 0.5, λ = 0.75). Zero compensability (λ = 0) was not considered, as we assumed that the primary indicators are substitutable.

4. Data presentation and data analysis steps

This study is based on secondary data from Eurobarometer 92.4 [62] on 'Attitudes of European Citizens towards the environment'. The advantage of using this survey is that it includes indicators for the four dimensions of environmental consciousness considered in the theoretical model. In addition, we had the opportunity to compare indicators across countries and over time. The Eurobarometer survey is designed to monitor political and social attitudes in the European Union on an ongoing basis. The overall objective, accordingly, is to know the attitudes and opinions of European citizens on certain issues of broad general interest. The questions focus primarily on European integration, but sometimes also include specific problems of individual countries or common economic, political and social issues.

The topic of EB 92.4 is the attitudes of European citizens towards perceptions of climate change, attitudes towards environmental issues, sources of information on environmental issues, environmental activities individual sustainability, concerns about environmental issues, evaluation of environmental behaviour, environmental issues of institutional actors, attitudes towards plastic recycling and air quality.

The anonymized EB 92.4 data include information on 27498 citizen-consumers from the 28 EU Member States, approximately 1000 individuals per country.

The primary indicators used to construct the composite indicator of environmental consciousness are shown in Table 2. The choice of indicators follows the above-mentioned theoretical model of Sanchez and Lafuente [18] and data availability. The choice of primary indicators is also consistent with previous work on the same topic (e.g., Ref. [7]).

[2] This optimum value represents a maximum value if (as in our case) the indicator is of the type 'more is better'.

Table 2
Primary indicators used to construct the composite Environmental Consciousness indicator.[a]

Dimension	Facet	Items/questions	Variable type (range)	Shortened variable name
Affective	Perceived importance of Environmental issues	QA1. How important is protecting the environment to you personally?	Ordinal-scale (1–4)	V1
		QA2_1. How serious a problem do you think climate change is at the moment in your country?	Interval-scale (1-10)	V2
		QA2_2. How serious a problem do you think climate change is at the moment in Europe	Interval-scale (1-10)	V3
		QA3. Up to four environmental issues which you consider the most important	Count (0–4)	V4
		QA7_1. Environmental issues have a direct effect on your daily life and health.	Ordinal-scale (1–4)	V5
		QA7_2. Your consumption habits adversely affect the environment in Europe and the rest of the world.	Ordinal-scale (1–4)	V6
		QA7_3. You are worried about the environmental impact of everyday products made of plastic.	Ordinal-scale (1–4)	V7
		QA7_4. You are worried about the environmental impact of microplastic.	Ordinal-scale (1–4)	V8
		QA7_5. You are worried about the impact of chemicals present in everyday products on your health.	Ordinal-scale (1–4)	V9
		QA7_6. You are worried about the impact of chemicals present in everyday products on the environment.	Ordinal-scale (1–4)	V10
		QA14_4. You are not interested in how environmentally friendly your clothes are.	Ordinal-scale (1–4)	V11
Cognitive	Level of available information	QA4. Up to three main sources of information about the environment	Count (0–3)	V12
Active	Engagement in buying behaviour (pure)	QA6_2. Avoided buying over-packaged products (yes/no) QA6_7. Bought products marked with an environmental label (yes7 no) QA6_8. Bought local products (yes/no) QA6_13. Bought second-hand products instead of new ones	Count of yes (0–4)	V13
	Engagement in behaviour aimed at reducing and efficient buying (mixed)	QA6_1. Chosen a more environmentally friendly way of travelling QA6_3. Avoided single-use plastic goods other than plastic bags or bought reusable plastic products QA6_4. Separated most of your waste for recycling QA6_5. Cut down your water consumption QA6_6. Cut down your energy consumption QA6_9. Used your car less by avoiding unnecessary trips, working from home QA6_10. Joined a demonstration, attended a workshop, taken part in an activity. QA6_11. Changed your diet to more sustainable food. QA6_12. Spoken to others about environmental issues. QA6_14. Repaired a product instead of replacing it.	Count of yes (0-10)	V14
Dispositional	Individual sense of responsibility	QA9_2. Are citizens themselves doing too much about the right amount, or not enough to protect the environment?	Ordinal-scale (1–3)	V15
		QA9_3. Is your city, town or village doing too much about the right amount, or not enough to protect the environment?	Ordinal-scale (1–3)	V16

(*continued on next page*)

Table 2 (*continued*)

Dimension	Facet	Items/questions	Variable type (range)	Shortened variable name
		QA10_12 Changing the way we consume	Binary (0–1)	V17
	Personal Costs	QA12_3. Consumers should play an extra charge for single-use plastic goods	Ordinal-scale (1–4)	V18
		QA13_6. Clothes should be available at the lowest possible price, regardless of the environment or the working conditions under which they were made.	Ordinal-scale (1–4)	V19

[a] The items were taken from the Special Eurobarometer 92.4 conducted in December 2019. The full questionnaire and variable report are available at: https://search.gesis.org/research_data/ZA7602.

In total, we considered 19 indicators: 11 for the affective dimension, 1 for the cognitive dimension, 2 for the dispositional dimension and 5 for the active dimension.

The variables selected and presented in Table 2 refer to questions with a different response scale. In some cases, it was necessary to rotate the response scale so that an increase in the normalized indicators corresponds to an increase in the composite indicator [60]. All missing values were imputed or removed from the dataset. As a result, the sample size used in the analysis was reduced to 27378 respondents. The analysis proceeded in several stages. First, indicators were normalized. Second, indicators weights were obtained using the PCA-based strategy illustrated in the methodology section. Third, indicators were aggregated by considering different levels of compensability. Finally, a further level of aggregation was employed to obtain an index by country. All analyses were carried out using SAS 9.4 statistical software.

5. Results

5.1. Weighting of indicators

First, to assign weights to each primary indicator, a PCA was performed using the 19 primary indicators as input. As the PCA was based on the correlation matrix the number of significant principal components was selected by retaining the components with the corresponding eigenvalue (λ) >1 [63] and based on the percentage of the overall variance explained. Following this step seven principal components, explaining the 72.65 % of the total variance, were retained. The subsequent interpretation of the principal components is based on finding which variables are most highly correlated with each component, i.e., which of these figures are large in magnitude, the farthest from zero in either direction. Here a correlation above 0.5 is deemed important. These larger correlations are shown in bold in Table 3.

1. *Prin 1*, explaining 31 % of the total variance, may be interpreted as a general measure of affective dimension.
2. *Prin 2*, explaining 11.6 % of the total variance, may be interpreted as a measure of active dimension. Is the only component which captures both pure and mixed aspects of the engagement in buying behaviour.
3. *Prin 3*, explaining 8.27 % of the total variance, may be interpreted as a measure of dispositional dimension, capturing only the elements related to the individual sense of responsibility.
4. *Prin 4*, explaining the 6.34 % of the total variability, may be interpreted as the climate change concern only pertaining to the affective dimension.
5. *Prin 5* and *Prin 6*, explaining 5.29 % and 5.10 % of the total variance respectively, be interpreted as a measure of the dispositional dimension, capturing the need to change consumption behaviour.
6. *Prin 7*, explaining 4.88 % of the total variance, may be interpreted as a measure of dispositional dimension, capturing only the elements related to the personal cost of adopting pro-environmental behaviour.

5.2. Aggregation of the indicators

After constructing the weights according to Diaz-Balteiro and

Table 3
Correlation Components-primary indicators.

Principal Component	Prin1 Affective (general)	Prin2 Active (Pure, Mixed)	Prin3 Dispositional (individual sense of responsibility)	Prin4 Affective (climate change concern)	Prin5	Prin6 Dispositional (new consumption behaviour)	Prin7 Dispositional (personal costs)
% variance explained	31 %	11.6 %	8.27 %	6.34 %	5.29 %	5.10 %	4.88 %
V1	**0.72**	0.03	0.01	−0.15	−0.07	−0.02	0.04
V2	**0.62**	−0.23	0.36	**−0.57**	0.02	0.02	0.11
V3	**0.62**	−0.16	0.38	**−0.59**	0.00	0.01	0.11
V4	**0.53**	0.43	0.10	0.05	0.11	−0.36	0.21
V5	**0.66**	−0.38	−0.22	0.11	−0.02	−0.03	0.08
V6	−0.49	0.27	0.16	−0.05	−0.20	−0.21	0.16
V7	**0.79**	−0.10	−0.25	0.09	−0.05	0.06	−0.04
V8	**0.79**	−0.03	−0.24	0.07	−0.11	0.06	−0.05
V9	**0.73**	−0.29	−0.29	0.17	−0.16	−0.07	0.11
V10	**0.81**	−0.17	−0.28	0.13	−0.12	0.00	0.06
V11	0.39	0.41	0.02	0.01	−0.48	0.36	−0.04
V12	0.42	**0.57**	−0.07	0.07	0.22	−0.34	0.06
V13	0.40	**0.54**	−0.01	0.00	0.17	−0.04	−0.12
V14	**0.51**	**0.56**	−0.03	−0.04	0.09	−0.14	−0.04
V15	0.42	−0.09	**0.67**	0.45	−0.02	−0.02	−0.05
V16	0.38	−0.23	**0.68**	0.43	−0.04	−0.03	−0.06
V17	0.16	0.16	0.02	0.15	**0.57**	**0.60**	0.45
V18	0.35	−0.08	0.01	−0.11	0.40	0.09	**−0.74**
V19	0.09	**0.63**	0.12	−0.038	−0.39	0.39	−0.16

Romero [56], we aggregated the primary indicators with different levels of compensability as in (8), thus obtaining the composite indicator.

The type of indicators affects the choice of the aggregation method. The components of a composite index are said to be 'substitutable' if a deficit in one component can be compensated by a surplus in another component. The primary indicators used in the ECI are deemed substitutable, so we allowed different degrees of compensation. A non-compensatory aggregation represented by $\lambda = 0$ was therefore not taken into consideration. After calculating the composite indicator, we converted it on a scale from 0 to 100. For $\lambda = 1$ (Table 4), the overall mean obtained is 57.38 points, which is not very different from the median (57.73 points); the deviation interquartile range, on the other hand, is about 24.17 points, with the first quartile enclosing all subjects with a score below 48.55 points, and the third quartile enclosing subjects with a score up to a maximum of 66.67 points.

After simply looking at the distribution of our indicator, we compared the averages and medians of European countries to see which countries were the ones whose citizens show higher environmental consciousness.

First, we can see that the distribution of our indicator 'is quite heterogeneous' among the different geographical areas considered. On the map (Fig. 4) we can see areas with a higher level of environmental consciousness. As we would have expected, areas in the Scandinavian countries (e.g., Sweden) are at the top of our ranking, and such a result is in line with other studies (e.g., Ref. [64]).

By varying lambda ($\lambda = 0.25$, $\lambda = 0.50$, $\lambda = 0.75$), the distribution of countries in terms environmental consciousness appears to be almost the same.[1] To evaluate the degree of agreement among the set of m ranks, with $m > 2$, (for the n countries generated by the composite indicator ECI) we use the Kendall's coefficient of concordance W [65,66], as in (9):

$$W = \frac{12S^2}{m^2(n^3 - n)} - \frac{3(n+1)}{n-1} \tag{9}$$

where $m = 4$ (one for each compensation parameter λ value considered), $n = 28$ (number of countries considered in the analysis), r_{ij} = ranking of country i by method j, $R_i = \sum_{j=1}^{m} r_{ij}$ and $S^2 = \sum_{i=1}^{n} R_i^2$. To test the significance of W, i.e., whether there is sufficient concordance in the 4 rankings generated by different levels of λ, we use the Friedman [67] χ_r^2 statistic, $\chi_r^2 = m(n-1)W$, which has an approximate chi-squared distribution with (n-1) degrees of freedom [68]. When the 4 rankings are considered simultaneously, Kendall's W indicates a maximum degree of agreement (W = 1[3]). Although the discussion of the most appropriate value of the compensation parameter to measure environmental consciousness is beyond the scope of this paper, it is worth noting that the ranking of the countries in terms of their level of environmental consciousness, as measured by the proposed composite indicator, is not dependent on the use of different compensation parameters.

Table 4
Descriptive statistics of the composite indicator by compensation parameter (λ).

Degree of compensability	Mean	Median	Min	Max	St.Dev	CV
$\lambda = 0.25$	57.37	57.72	0	100	13.87	24.17
$\lambda = 0.50$	57.38	57.73	0	100	13.87	24.17
$\lambda = 0.75$	57.39	57.74	0	100	13.87	24.17
$\lambda = 1$	57.39	57.74	0	100	13.87	24.17

[3] Kendall's coefficient of concordance can take values in the interval [0,1]. It takes the maximum value 1 when there is a perfect agreement among the m sets of ranks. This coefficient can take the minimum value zero when there is no agreement.

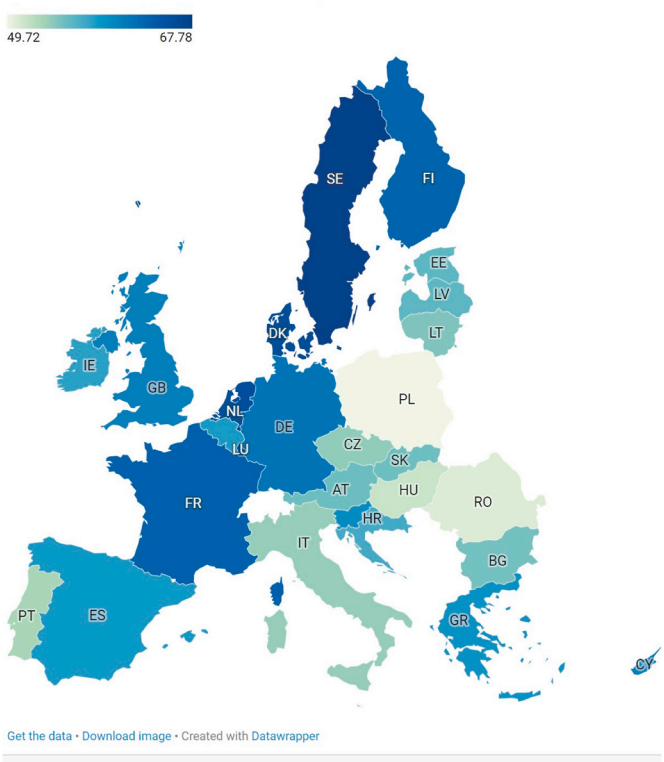

Fig. 4. European map of environmental consciousness (2019) ($\lambda = 1$). Median of ECI by country. Own elaboration of EB92.4 data.

5.3. Robustness check: life satisfaction and ECI

As anticipated the relationship between the composite indicator and life satisfaction was tested at the country and individual level.

Fig. 5 shows a clear positive Spearman correlation between the ECI

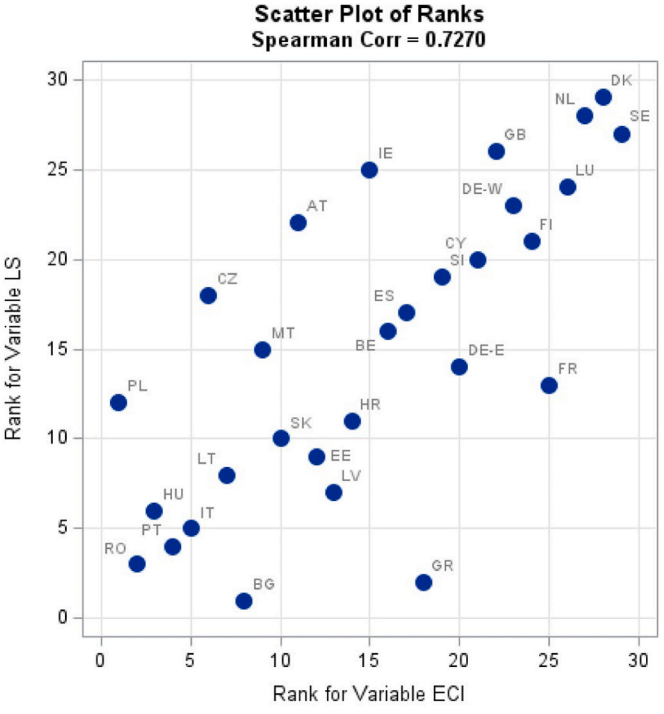

Fig. 5. Correlation between Environmental Consciousness Index (ECI) and Life Satisfaction (LS) by country.

and life satisfaction in the country.

At the individual level, the life satisfaction indicator was used as an outcome in an ordered regression model [69,70] to analyse its relationship with the derived ECI. Life satisfaction is measured on a scale from 1 ('Very satisfied') to 4 ('Not at all satisfied') by asking to respondents the following question: "On the whole, are you very satisfied, fairly satisfied, not very satisfied or not at all satisfied with the life you lead?". The most widely used model for ordered response variable is the ordered probit model. This model can be derived from a latent variable model [69].

Let assume y^* to be a latent variable determined by (10):

$$y^* = \boldsymbol{x\beta} + e, e|\boldsymbol{x} \sim Normal\ (0,1) \tag{10}$$

where $\boldsymbol{\beta}$ is k x 1, and **x** does not contain a constant.[4]

We observed the discrete variable y (*Life Satisfaction)* which can take a limited number of values ('Not at all Satisfied', 'Not very Satisfied', 'Fairly Satisfied', 'Very Satisfied').

The relationship between y (observed) and y^* (latent) is reported in (11)–(14):

$$y = 0\ if\quad y^* < \alpha_1; \tag{11}$$

$$y = 1\ if\ \alpha_1 \le y^* < \alpha_2; \tag{12}$$

$$y = 2\ if\ \alpha_2 \le y^* < \alpha_3; \tag{13}$$

$$y = 3\ if\quad y^* \ge \alpha_3. \tag{14}$$

Since we assumed standard normal for e, we need to find the conditional distribution of y given **x**. Each response probability is calculated as in (15)-(18):

$$\Pr(y=0|\boldsymbol{x}) = \Pr(y^* < \alpha_1|\boldsymbol{x}) = \Pr(\boldsymbol{x\beta} + e < \alpha_1|\boldsymbol{x}) = \phi(\alpha_1 - \boldsymbol{x\beta}) \tag{15}$$

$$\Pr(y=1|\boldsymbol{x}) = \Pr(\alpha_1 < y^* < \alpha_2|\boldsymbol{x}) = \phi(\alpha_2 - \boldsymbol{x\beta}) - \phi(\alpha_1 - \boldsymbol{x\beta}) \tag{16}$$

$$\Pr(y=2|\boldsymbol{x}) = \Pr(\alpha_2 < y^* < \alpha_3|\boldsymbol{x}) = \phi(\alpha_3 - \boldsymbol{x\beta}) - \phi(\alpha_2 - \boldsymbol{x\beta}) \tag{17}$$

$$\Pr(y=3|\boldsymbol{x}) = \Pr(y^* \ge \alpha_3|\boldsymbol{x}) = 1 - \phi(\alpha_3 - \boldsymbol{x\beta}) \tag{18}$$

where $\phi(.)$ indicates the standard normal cumulative distribution function (CDF). The parameters α and β are estimated by maximum likelihood. For each i, the log-likelihood function is as in (19):

$$l_i(\boldsymbol{\alpha},\boldsymbol{\beta}) = 1[y_i=0]\log[\phi(\alpha_1 - x_i\beta)] + 1[y_i=1]\log[\phi(\alpha_2 - x_i\beta) - \phi(\alpha_1 - x_i\beta)] + 1[y_i=2]\log[\phi(\alpha_3 - x_i\beta) - \phi(\alpha_2 - x_i\beta)] + 1[y_i=3]\log[1 - \phi(\alpha_3 - x_i\beta)] \tag{19}$$

A set of control variables were included in the model: gender, age, number of years of education, marital status, household composition, perceived difficulty in paying bills and social class (based on the perception of the respondent). The role of these control variables was to ensure that the link between ECI and life satisfaction might hold when controlling for individual characteristics of each respondent that might also influence life satisfaction. As mentioned in the research framework, we expect a positive relationship between ECI and life satisfaction. The results were in line with our expectations: ECI displays a positive and significant relationship with life satisfaction (odds estimate = 1.0192, $p < .001$): for a one unit increase in the ECI, the odds of high life satisfaction[5] increase by about 2 % compared to the combined lower levels.

[4] If **x** contains a constant term, it is impossible to identify the constant along with α_1 and α_2, therefore we just set the constant = 0.

[5] The response scale of the Life satisfaction was rotated first in order to have high value corresponding to high life satisfaction.

5.4. Robustness check: public interest in environment related issues and ECI

Finally, to further test the robustness of our composite indicator, we analyse the relationship between our composite indicator and Google Trends (hereafter GT) data on the number of searches on environmental topics in several countries. We chose to test the robustness of our indicator using GT data because it avoids the problems with telephone, mail, and email surveys which are subject to non-response bias [71,72], lying and suspicion [73], and observational studies, which often involve ethical and moral questions. Furthermore, Google search data have been shown in several recent studies to be as accurate as surveys in accessing public interest in a given topic [74].

Information seeking is a key driver of pro-environmental behaviour [75]. Consumers who are more environmentally aware are more likely to search for additional information about the environmental characteristics of products [32,76]. Searching information is a behaviour that can be thought to be positively related to each of the dimensions of Environmental Consciousness: it involves the acquisition of information (cognitive), it may stem from a concern for the environment (affective), it signals a personal commitment to environmental matters (dispositional), and it reflects an actual behaviour oriented towards the environment (active). We therefore expect a positive relationship between our composite index at the country level and the number of searches on Google Trends per country.

Google is the most popular search engine on the World Wide Web, accounting for more than 90 % of monthly web searches worldwide (Statista). In Europe, Google is the most used search engine online with a market share of more than 90 % [77]. Google Trends is a powerful tool that provides access to an "anonymized, categorized and aggregated sample" (Google, 2023) of actual search requests made on google.com about a specific search term. The latter is differentiated from Google Trends in terms of keywords or topics. While keywords are user-defined and subject to calculation errors or differences due to the articulation of lemmatical terms, topics are defined by Google as a collection of search terms related to a specific macro argument. Data collected using GT has previously been used to study many phenomena (Scharkow and Vogelgesang 2009[78]; [79]), including topics related to the environment. For instance, it has been used to study the interest in the environment and biodiversity [80]. In their paper, McCallum and Bury [80] used Google Insights for Search to assess 19 environment-related terms from 2001 to 2009. Rousseau and Deschacht [81], by analysing online search behaviour in twenty European countries, investigated how public awareness of nature and the environment evolved during the COVID-19 crisis. We referred to the above-mentioned literature to decide which search term to use in our analysis.

Specifically, for the purpose of this study, 3 environmental-related search topics were queried: "climate change", "environmental issues", "sustainability". Using the topic instead of the keyword had the advantage of avoiding spelling or omission mistakes. Moreover, as the topics are language-neutral, the problem of the choice of language does not arise.

In order to assess the robustness of the aggregate environmental consciousness composite index by country, we then compared it with the ranking of countries based on the search popularity of the three topics. To ensure the temporal consistency of the comparison, we chose to take as the reference period of Google Trends searches the period from 06 to 12–2019 to 19-12-2019, which basically follows the reference period of the Eurobarometer survey data collection.

In response to investigator queries, GT reports how often the worldwide population of internet users searches Google for a given term as a proportion of the total of all Google searches during the given range of dates. Google excludes repeated queries from a single user over a short time-period to avoid pseudo-replication of web searches.

The dataset released by Google Trends contains for each country and each queried topic 14 observations and two variables (Table 5).

Table 5
Description of topic dataset (Country x).

Variable	Description	Type	Outcome
date	Date by day	date	yyyy-mm-dd
RSV	Relative search volume of the topic 'Climate Change'	Integer	[32, 100]

The search volume was recorded for each of the 14 days on a sample randomly drown from a population of billions of searches per day (e.g., Ref. [81]). Google Trends provides a search volume value (RSV) that is relative and normalized as in (20) [81]:

$$RSV_{i,t}^{z} = \frac{\theta_{t,z}^{i}}{max\left\{\theta_{t,z}^{i}\right\}}, i\epsilon I, t\epsilon T \tag{20}$$

where I is the set of search terms or topics (e.g., the topic 'climate change'), t is a time unit within the time horizon T (e.g., each day in the specified period), and z the chosen geographical region (e.g., France). The numerator in (20) represents the number of searches for term i, during the point time t in region z. If this number is lower than a certain (unspecified) threshold, it is set to zero. The RSV is computed for each search term of the topic I, in each unit period of the time horizon T. The resulting values are scaled based on the topic's proportion to all searches of a topic in a range of 0–100, starting from the maximum relative search volume that is set to 100.

The numbers represent the search interest in relation to the highest point on the graph in relation to the region and time indicated. A value of 100 indicates the highest search frequency of the term, 50 indicates half of the searches. A score of 0, on the other hand, indicates that not enough data were found for the term.

Once the daily data was downloaded from GT, the average number of searches was calculated in the time span considered. The average value was used to make a ranking of countries with higher interest in the topics 'Climate Change', 'Environmental Issues' and 'Sustainability'. Therefore, we compared the rankings for 28 countries obtained as a result of constructing the indicator by varying lambda and according to the search popularity of the three different topics. The Kendall's W statistic indicated a significant level of concordance among the set of ranks obtained using GT and the set of ranks obtained using different levels of compensability for the composite indicator, thereby allowing us to reject the null hypothesis that there is no agreement among the rankings. The composite indicator, thus, displays a positive and significant relationship across countries with GT search term volumes.

6. Conclusions

6.1. Findings and implications

In the present study, we proposed and developed a composite indicator to measure environmental consciousness based on four dimensions defined in the framework of Sanchez and Lafuente [18]: the affective, cognitive, dispositional and active dimensions. The composite indicator has been employed to reveal the heterogeneity of Environmental Consciousness across European countries. Specifically, results showed that Sweden, Denmark and Netherlands outperform the rest of Europe, with Northen and Central-Western European countries showing - on average - higher environmental consciousness than Southern and Central-Eastern ones. We contribute to the stream of literature on environmental consciousness by proposing an indicator that can be employed to monitor environmental consciousness in multiple countries. This new indicator could enrich the current set of measures available to analyse environmental consciousness, and it extends to practice, at the micro and macro levels, the theoretical framework previously developed by Sanchez and Lafuente [18]. Our work thus contributes to the stream of studies (e.g., Ref. [7,49,46]) relying on four dimensions as key elements of Environmental Consciousness, by introducing a new composite indicator that is also related to life satisfaction and Google Trends data. The link between the composite indicator and life satisfaction has been investigated both at the micro and macro level. A positive and significant relationship exists: if environmental consciousness increases, life satisfaction increases as well. This result is in line with academic findings reporting a link between pro-environmental attitudes and behaviours and subjective well-being (e.g. Ref. [21]), thus offering additional support for the proposed indicator.

Finally, the indicator is also validated by employing an external data source, namely Google Trends (GT) data. Evidence shows that the indicator is associated with searches on environmental topics on Google. The concordance between rankings coming from GT data and the composite indicator points to the conclusion that GT data can be also employed as a proxy of environmental consciousness and, especially, reinforces the role of the composite indicator in measuring Environmental Consciousness at the macro level. This finding also offers room for future use of big data such as GT data to measure phenomenon at the macro level when data collected by means of other methodologies are not available, or it is not feasible or too costly to start a new data collection.

The present work entails several managerial and policy implications. First, the proposed composite index can be easily disseminated and interpreted [22]. Therefore, efforts should be made at every administrative level to employ the indicator to track how environmental consciousness evolves over time in different regions and countries. This would provide policy makers with a regional map of Environmental Consciousness. It would be possible to understand which areas should be prioritized for policy interventions when deciding on the allocation of funds and public investments, thus fostering a homogeneous diffusion of environmental consciousness. The composite indicator would also be useful for measuring the success of informative campaign aimed at promoting awareness among citizens about environmental issues, which would be the key prerequisite for undertaking concrete action in favour of the environment. Moreover, our study shows that policy makers can rely on multiple data sources to be able to measure environmental consciousness, especially when conducting surveys proves to be costly. Finally, results from the present study shows that being conscious of the environmental situation and its related challenges does not harm individual well-being. On the contrary, it can contribute to positive change, which could be reflected in higher levels of happiness and life satisfaction. With reference to managerial implications, the composite indicator could be very useful to multinational companies and companies willing to enter new markets in Europe. The indicator can offer accurate information on the level of environmental consciousness in each European country, thus supporting companies in orienting their marketing strategies towards sustainability in those countries that display higher environmental consciousness. In addition, the composite indicator could be also helpful when companies need to develop new products for new markets in order to guide their efforts towards green product innovation. Finally, it could be also useful to Human Resources as they might position the company differently in employer branding activities, according to the ECI in each country. This green positioning could help companies to attract and hire talents in those countries attributing high importance to the attention paid by the company to the environment.

6.2. Research limitations

The present study is not without its limitations. The ECI was developed using a cross-sectional survey. Surveys are limited not only by human and monetary resources, but also by participants' willingness to be included in research, language barriers and response bias. For what concerns the use of Google Trends data, they may be affected by socio-economic bias as countries with poor internet penetration are under-represented. Moreover, for privacy reasons, Google Trends provides an

index of normalized search volume, scaled according to the chosen time and location window, rather than the actual number of searches. The use of monitoring of Internet data overcomes the issues of resources, time, and physical location. The near real-time availability is another major advantage and may prove to be a much sought-after feature for business or policy analysis [82]. Finally, the relationship between the composite indicator and GT data was tested with reference to a short period of time.

6.3. Recommendations for future research

The present study also offers room for future studies on the topic. A longitudinal comparison between the composite indicator and GT data would yield more evidence for a correlation between these two variables. Future studies should test the composite indicator in multiple countries on other continents, to understand whether it could be applied in different contexts outside Europe. Future research could also use the composite indicator to understand the extent to which environmental consciousness might influence the purchasing behaviour of different generational cohorts of consumers, as well as to guide innovation and marketing strategies of companies. Furthermore, focusing on potential mediators and moderators in the link between environmental consciousness and life satisfaction would offer interesting theoretical contributions and implications.

Declarations of interest

none.

CRediT authorship contribution statement

Ida D'Attoma: Data curation, Formal analysis, Methodology, Supervision, Writing – original draft, Writing – review & editing. **Marco Ieva:** Conceptualization, Data curation, Supervision, Writing – original draft, Writing – review & editing.

Data availability

The authors do not have permission to share data.

Appendix 1. Detailed Rankings with the value of the composite index (ECI) for each Country

Country code	Country name	ECI	St dev	Coeff. of variation
AT	Austria	55.34	18.10	32.70
BE	Belgium	58.42	13.65	23.09
BG	Bulgaria	55.04	11.58	21.49
CY	Cyprus	60.72	10.83	18.02
CZ	Czech Republic	54.01	13.89	25.97
DE	Germany	61.67	13.71	21.92
DK	Denmark	66.01	13.44	20.81
EE	Estonia	55.85	13.42	24.49
ES	Spain	58.52	11.92	20.21
FI	Finland	63.22	12.87	20.73
FR	France	63.45	13.38	21.20
GR	Greece	59.13	10.81	18.39
HR	Croatia	57.18	13.47	24.43
HU	Hungary	51.55	11.17	22.00
IE	Ireland	58.02	13.78	24.07
IT	Italy	53.80	12.33	23.33
LT	Lithuania	54.68	11.94	22.14
LU	Luxemburg	64.81	13.44	20.87
LV	Latvia	55.93	11.84	21.60
MT	Malta	55.11	11.91	21.74
NL	Netherlands	65.71	12.13	18.62
PL	Poland	49.72	14.05	28.21
PT	Portugal	53.02	10.76	20.11
RO	Romania	50.67	12.28	24.91
SE	Sweden	67.77	12.97	19.35
SI	Slovenia	59.66	14.37	24.45
SK	Slovakia	55.21	11.97	21.90
UK	United Kingdom	60.79	13.82	22.80

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