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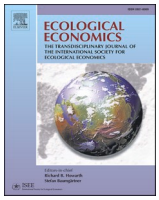

Analysis

Sustainable consumption behavior of Europeans: The influence of environmental knowledge and risk perception on environmental concern and behavioral intention

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ABSTRACT

This study explores how environmental knowledge and risk perception influence individuals' sustainable consumption behavior through the mediation of environmental concern and behavioral intention. The study combines constructs from earlier studies to form a novel theoretical model, which is tested and validated with an open data set from the Environment III 2010 module, which was collected by the International Social Survey Programme (ISSP). Our sample consists of respondents from nine countries ($N = 11{,}675$) in the European Union (EU) and the European Free Trade Association (EFTA). The model indicates that environmental risk perception and environmental knowledge impact environmental concern significantly. Furthermore, environmental concern strongly influences behavioral intention, and these constructs, in turn, act as mediators of sustainable consumption behavior. The findings indicate that in Europe, sustainable consumption behavior can be associated with environmental concern, which is influenced by increased levels of environmental knowledge and environmental risk perception. The results provide a basis for future analyses once the Environment IV module is released. This will be of particular importance for tracking possible changes in the sustainable consumption behavior of Europeans when transitioning to a green and circular economy that is driven by the European Green Deal and EU Circular Economy Action Plan.

1. Introduction

With the growing pace of environmental degradation, climate change, and resulting crises, it is increasingly urgent that people transform their consumption behavior to become more sustainable to ensure safe and healthy living conditions for current and future generations (IPCC, 2018). Nevertheless, most people still seem to regard the economy as being primarily connected with the production and consumption of physical products, even though researchers have shown that humans are consuming products and using services faster than the natural ecosystem can regenerate, process, or recycle (e.g. Rees, 2020; Wackernagel et al., 2002). The current consumption culture needs to change to enable the transition to a circular economy; otherwise, EU-level policies, such as the European Green Deal (European Commission, 2019) and the Circular Economy Action Plan (European Commission, 2020), will remain merely theoretical tools that will not alter the course of the current unsustainable economic paradigm (Korhonen et al., 2018).

Although theories on sustainable consumption behavior have been developed since the 1980s, due to the multifaceted nature of the phenomenon and various operationalizations, a call still remains for additional research on the underlying constructs (Dunlap, 2017). For example, there has been a call for research that analyzes the associations between pairs of variables rather than single variables, to evaluate the predictive power of environmental concern (Tam and Chan, 2018). Our study seeks to understand the determinants of sustainable consumption behavior from the micro-level perspective of individuals' environmental concern, which is the result of environmental knowledge and risk

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perception (Marquart-Pyatt, 2015; Vainio and Paloniemi, 2014). In earlier research, the causal relationships and mechanisms between environmental concern and behavioral intention with regard to sustainable consumption behavior have remained hypothetical (Vainio and Paloniemi, 2014). As the relationship between environmental concern and sustainable consumption behavior is complex (Dunlap, 2017), additional models need to be developed that include factors which influence individuals' environmental concern and the impact of these factors on behavioral intention and actual behavior (Nauges and Wheeler, 2017). Studies have yet to explore whether there is a direct relationship between environmental knowledge, risk perception, and environmental concern, as well as how environmental concern influences the behavioral intention and sustainable consumption behavior in Europe. Our theoretical model extends previous models on sustainable consumption behavior by hypothesizing that environmental concern influences the behavioral intention of individuals, which has a mediating impact on sustainable consumption behavior. We use data collected from individuals living in nine countries in the European Union (EU) and the European Free Trade Association (EFTA) from the Environment III 2010 open data set, which was collected by the International Social Survey Programme in 2010–2011[1] (ISSP Research Group, 2012). These nine countries have recently been ranked among the top 10 countries based on their 2020 SDG index scores (Sachs et al., 2020).

Due to the worldwide differences in environmental degradation, levels of environmental awareness and types of environmental policies, we focus on countries within the EU and EFTA, where, since the establishment of the European Environment Agency (EEA) in 1990, there has been a special interest in the state of the environment on the European level. European politics and public media have addressed environmental themes for three decades, as the EEA has operated since the 1990s to support the development and implementation of environmental policies, to inform the general public on environmental matters, and to integrate environmental concerns into other EU policy areas (European Parliament, 2019). Hence, Europeans have received information on the state of the environment and its degradation, and on related policies and actions on the European level. The European Commission published Europe's new agenda for sustainable growth, namely the European Green Deal (European Commission, 2019), in December 2019, followed by the EU Circular Economy Action Plan in March 2020 (European Commission, 2020). These European-level initiatives aim at advancing environmental awareness and action; however, the impact of these latest guidelines and plans cannot be measured yet, because large-scale changes require several years to be implemented. It is equally important to identify the impact of earlier European-level activities on the micro level to establish a baseline for tracking the future progress in sustainable consumption behavior of Europeans.

In our study, we focus on four core perspectives of sustainability economics: (1) the relationship between humans and nature in society with regard to sustainable consumption behavior; (2) the long-term and uncertain future by drawing conclusions from a causal-predictive perspective, using partial least squares structural equation modeling (PLS-SEM) to analyze the factors that impact sustainable consumption behavior; (3) justice toward future generations and nature by conceptualizing and verifying a model that could be applied in future studies to track the development of Europeans' sustainable consumption behavior; and (4) economic efficiency in terms of non-wastefulness by examining the sustainable consumption behavior of individuals living in Europe (Baumgärtner and Quaas, 2010). Thereby, we aim to answer the following research question: *How do environmental knowledge, risk perception, environmental concern, and behavioral intention influence sustainable consumption behavior in Europe?*

In our study, we find that environmental knowledge and risk perception influence environmental concern, and both environmental concern and behavioral intention act as mediators of sustainable consumption behavior of Europeans. Consequently, this article makes two major contributions: 1) our findings provide evidence for the relevance of individuals' environmental knowledge and risk perception, which lead to more sustainable consumption behavior in terms of water usage, energy consumption, and purchase of sustainably grown food products; and 2) the resulting model can be used as a base model in future research on the development of European individuals' sustainable consumption behavior. Once the Environment IV module is released (estimated to be some time in 2022; ISSP, 2020), the status of the transition to the green and circular economy can be measured from the perspective of individuals' sustainable consumption behavior. This will also enable the initial assessment of the effectiveness of the policies that enforce the European Green Deal and the EU Circular Economy Action Plan.

The remainder of this article is structured as follows: section two presents the theoretical background, the constructs of our theoretical model, and the development of the main hypotheses; section three describes the data set and methodology used; section four summarizes the most important findings; section five discusses the findings in theoretical and practical terms; and section six concludes our study by suggesting further research avenues.

2. Theoretical background and hypotheses

In the 1980s, Van Liere and Dunlap (1981) started to create multi-item measures to operationalize the construct of environmental concern, which have been developed further throughout the decades using confirmatory factor analysis (CFA) and structural equation modeling (SEM) (Marquart-Pyatt, 2015; Xiao and Dunlap, 2007). Earlier research on sustainable consumption behavior focused on either the attitude-behavior gap or the concern-behavior gap (Carrington et al., 2014; Tam and Chan, 2018). In recent studies within the European context, the focus has shifted to the development and operationalization of constructs that are related to environmental risk perception (e.g., Hadler and Kraemer, 2017), environmental concern (Schaffrin and Schmidt-Catran, 2017), and pro-environmental behavior (e.g., Butkeviciene and Morkevicius, 2017). Our study focuses on creating a novel model in which environmental knowledge and risk perception act as antecedents of environmental concern, influencing behavioral intention, which jointly mediate sustainable consumption behavior. We target factors that impact sustainable consumption behavior in order to identify those that can be influenced by policy makers, for example, by providing information on environmental risks and enhancing people's environmental knowledge by means of environmental education.

2.1. Sustainable consumption behavior

Sustainable consumption behavior is a private-sphere environmental behavior with direct environmental consequences (Stern, 2000). Sustainable consumption behavior is often associated with pro-environmental consumption behavior, which is an aspect of individuals' behavior that helps reducing their negative impact on the environment (Dhandra, 2019). Pro-environmental behavior can be defined as behavior that causes minimal harm, or is beneficial to the environment (Steg and Vlek, 2009). In consumer research, the social psychological approach, and more specifically, the theory of planned behavior (TPB; Ajzen, 1991), has been predominant in research on sustainable consumer behavior, for example, when predicting the behavior of individuals in connection with the disposal of household waste (Ari and Yilmaz, 2016; Mannetti et al., 2004), water conservation,

[1] The Environment III data set, which was collected for the International Social Survey Programme (ISSP), was monitored by the ISSP methodology committee (Gendall, 2012). The monitoring committee ensured that the data collected in the ISSP studies were comparable across countries. The monitoring report (Gendall, 2012) provides additional details on the data collection process.

and green consumerism (Turaga et al., 2010). The TPB (Ajzen, 1991) is often used to measure pro-environmental behavioral intention and actual behavior. Many studies using the TPB indicate that attitudes, subjective norms, and behavioral control can strongly influence consumers' purchasing intention (Yadav and Pathak, 2017).

The value-belief-norm (VBN) theory of environmental activism (Stern et al., 1999), which measures values, beliefs, and norms, is the most widely used theoretical model used by psychologists and sociologists to explain pro-environmental behavior. Psychological, sociological, and environmental studies have focused on values and moral norms when analyzing the environmental attitudes of individuals (Kollmuss and Agyeman, 2002; Nordlund and Garvill, 2002; Oreg and Katz-Gerro, 2006). In addition, knowledge and awareness of environmental issues have been highlighted as having an important influence on pro-environmental behavior (Eom et al., 2016; Klockner, 2013; Tam and Chan, 2018). Other social-psychological theories that are used to explain environmental behavior of individuals include the rational choice theory (Oreg and Katz-Gerro, 2006).

We have created a theoretical model with a construct for sustainable consumption behavior, which includes various practices that are associated with this behavior. These practices are related to individuals' efforts to behave more sustainably for environmental reasons, including making special efforts to buy fruit and vegetables that have been grown without pesticides, reducing energy consumption, saving water, and avoiding the purchase of environmentally unfriendly products. These decisions are highly relevant on a societal level due to the financial and environmental impacts they have.

2.2. Environmental knowledge

Environmental knowledge, or knowledge about environmental issues, refers to the information individuals have on the state of the environment, climate change, environmental views, and the ecological effects of consumption and production (Pagiaslis and Krontalis, 2014). Recent research findings show that in countries with a higher gross national income (GNI) per capita, the level of environmental knowledge is higher, indicating that in many countries environmental literacy has increased with an overall growth of their wealth (Guerra et al., 2016).

Knowledge has been listed as one of the factors influencing risk perception (Kim et al., 2014; Urban and Hoban, 1997). Thus, if people do not have sufficient knowledge of environmental issues, they cannot judge environmental risks (Keller et al., 2012). This has also been found to be the reason for the variation in risk perception levels between different countries. On the individual level, environmental risk perception is dependent on cognitive factors of risk perception and the level of individuals' knowledge of environmental issues (Balžekiene and Telešiene, 2017). Moreover, environmental concern depends on knowledge of the occurrence of environmental problems (Franzen and Meyer, 2010; Franzen and Vogl, 2013; Marquart-Pyatt, 2018). Detailed information regarding environmental issues can lead to higher levels of environmental concern (Marquart-Pyatt, 2008).

Against this background, environmental knowledge includes information not only about the negative impacts of environmental issues, but also about possible mitigation and corrective action strategies, and it shapes the attitudes and intentions of people (Laroche et al., 1996; Zsóka et al., 2013). In recent studies, environmental knowledge has been found to have an indirect impact on individuals' intention to participate in conservation efforts; it can thus be regarded as being important in models that aim at predicting individuals' environmental behavior (Gkargkavouzi et al., 2019; Paço and Lavrador, 2017). Recent studies show that knowledge could indirectly result in behavioral change by affecting the intention to engage in conservation efforts and could hence be used to predict behavioral intention and environmental behavior (Gkargkavouzi et al., 2019). Similar findings on the significant impact of environmental knowledge on behavior have been presented by Otto and Pensini (2017) and Paço and Lavrador (2017).

Although studies have questioned whether knowledge of environmental issues could increase sustainable consumption behavior arguing that consumers are not "unaware" of environmental issues (Vainio and Paloniemi, 2014; Wilsdon et al., 2005; Wynne, 1992), the importance of environmental knowledge in changing people's unsustainable consumption behavior has been highlighted (Pagiaslis and Krontalis, 2014; Zsóka et al., 2013). Scientific environmental knowledge is regarded as being crucial to actively change consumption behavior (Hadler and Haller, 2011). Individuals with more knowledge of environmental issues tend to show a more positive attitude toward the environment (Fraj-Andrés and Martínez-Salinas, 2007; Marquart-Pyatt, 2008) and an increased likelihood of sustainable consumption behavior (Hines et al., 1987; Macias, 2015). Enhancing the level of environmental knowledge is regarded as a strategy to increase sustainable consumption behavior—the type and delivery of information, along with the attained level of expertise, are crucial in this process (Blankenberg and Alhusen, 2018; Truelove and Gillis, 2018; Zsóka et al., 2013). All new information that individuals acquire on the state of the environment can impact their knowledge, which, in turn, can lead them to question and transform their lifestyles (Hobson, 2003) and thus also have an impact on their behavior.

Based on the theoretical background that is presented above, we posit that environmental knowledge significantly influences individuals' environmental risk perception as well as the level of environmental concern. Thus, the development of environmental concern depends on what people learn about environmental issues rather than vice versa. Moreover, even though environmental knowledge is responsible for inducing environmental concern, people could be interested in learning more about environmental issues after showing initial environmental concern. Based on the above, we propose the following hypotheses:

H1. *Enhanced knowledge about environmental issues leads to increased levels of risk perception.*

H2. *Enhanced knowledge about environmental issues leads to increased levels of environmental concern.*

H3. *Enhanced knowledge about environmental issues leads to increased levels of sustainable consumption behavior.*

2.3. Environmental risk perception

The concept of risk perception is often described as the result of cognitive activity involving the collection and interpretation of information and signals from uncertain impacts of events or from various technologies (Wachinger et al., 2012). Environmental risk perception focuses on individuals' observations of causes of negative outcomes in the natural environment (O'Connor et al., 1999). In contrast to environmental concern, which is a general concern about the environment, the perception of environmental impacts or risks is more associated with the actual causes of environmental problems and how they are understood by individuals. Individuals have been found to react in three distinct ways to environmental risks: having rational insight into the problem, being willing to act, and being emotionally affected by environmental degradation (Franzen and Vogl, 2013). Environmental issues are placed in the context of one's life, work, and social contacts (Bickerstaff and Walker, 2001).

Environmental risk perception has been found to be comparable across regions and countries, even though the level of risk perception might vary (Marquart-Pyatt, 2015). This country level variation is influenced by, for example, various types of social, political, and cultural processes (Bickerstaff, 2004; Marquart-Pyatt, 2012). Cross-national studies have shown that people globally perceive environmental risks on various dimensions that relate to their attitudes and behavior (Arbuthnot and Lingg, 1975; Dunlap and York, 2008; Franzen and Meyer, 2010; Hadler and Haller, 2013).

Furthermore, individuals' risk perception can vary according to

different external contexts and external pressures resulting from societal and economic crises, rapid societal transformation or clearly visible environmental degradation. This can add to the environmental concern of individuals, as hypothesized in our model. However, researchers have also noted that the direction of the causality and relation of these variables are not clear (Balžekiene and Telešiene, 2017). In theory, this causality could also be reversed in some cases, so that increased levels of environmental concern could lead to higher levels of risk perception regarding environmental issues. In our model, we consider environmental concern to be a dynamic condition, as it has been found to be associated strongly with risk perception at the individual level as a result of changing environmental conditions.

In the ISSP data set, environmental risk perception is measured by asking respondents about their views on the causes of environmental problems, for example, whether they support the views that cars and industry cause air pollution or that climate change causes a rise in the world's temperature. These types of risk perceptions have also been considered to be predictors of sustainable consumption behavior on the individual level because they cause emotional responses, for example environmental concern, to the state of the environment and its degradation, thereby resulting in stronger individual commitment to the environmental causes (Chawla, 1999; Wang, 2017). With reference to the above, the following hypotheses are proposed:

H4. *Higher levels of risk perception regarding environmental issues lead to increased levels of environmental concern.*

H5. *Higher levels of risk perception regarding environmental issues lead to increased levels of sustainable consumption behavior.*

2.4. Environmental concern

Vainio and Paloniemi (2014) define environmental concern with reference to overall value orientation toward the natural environment, the level of worry about the future of the environment, and to the way human progress is harming the environment. Franzen and Meyer (2010) define environmental concern as an individual's awareness of the environment being threatened by pollution or resource overuse.

Environmental attitudes can greatly influence behavioral intention or willingness to sacrifice (Aldrich et al., 2007; Kotchen and Reiling, 2000). However, research studies were not always able to replicate this finding, suggesting that such a relationship could depend on the definition of sustainable consumption behavior (Choi and Fielding, 2013; Cooper et al., 2004). Even though environmental concern is growing among consumers, studies have not directly shown that people would be willing to sacrifice more for the environment, but it could, nevertheless, increase their behavioral intention (Nordlund and Garvill, 2002). Environmental concern is typically associated with sustainable consumption behavior (Fraj-Andrés and Martínez-Salinas, 2007; Wakefield et al., 2006), willingness to sacrifice or to pay a premium price for more sustainable products (Meyer and Liebe, 2010), and even energy consumption behavior (Sapci and Considine, 2014).

According to earlier research findings, the influence of environmental concern on consumption behavior is an important factor that may lead to increased sustainable consumption behavior (Minton and Rose, 1997; Roberts and Bacon, 1997). Nevertheless, the link between environmental concern and sustainable consumption behavior is not straightforward, as other factors influence consumption behavior, such as the societal (Oreg and Katz-Gerro, 2006; Straughan and Roberts, 1999; Vermeir and Verbeke, 2006, 2008; Wang, 2017) and political context (Nawrotzki, 2012). Recent research findings demonstrate that individuals are prepared to pay in order to decrease the cognitive dissonance they experience between their pro-environmental attitudes and their rational understanding of the environmental impact of their behavior only in cases where the cost associated with pro-environmental behavior is low (Farjam et al., 2019). Studies have shown that high levels of environmental concern on their own do not promote sustainable consumption behavior among consumers (Bang et al., 2000; Kollmuss and Agyeman, 2002; Poortinga et al., 2004; Wang, 2017). Recent studies identify patterns regarding the expression of environmental views by the public, which suggest that environmental concerns are global public concerns (Franzen and Vogl, 2013; Givens and Jorgenson, 2013; Hadler and Haller, 2011, 2013).

In developing our hypothesis on the overall influence of environmental concern on behavioral intention to act more sustainably and on sustainable consumption behavior, we take the theoretical background into account, as well as the fact that the environmental psychology literature suggests that the relationship between environmental attitudes and behavioral intention is weak and that environmental concern is likely to impact behavior indirectly (Bamberg, 2003). Furthermore, supported by Ajzen's (1991) TPB theory and Stern's (2000) VBN theory, we establish the following hypothesis:

H6. *Higher levels of environmental concern lead to increased behavioral intention to positively contribute to the environment.*

H7. *Higher levels of environmental concern lead to increased sustainable consumption behavior.*

2.5. Behavioral intention

Behavioral intention—with regard to sustainable consumption behavior—refers to people's willingness to act and consume more sustainably by making sacrifices or by paying more (Marquart-Pyatt, 2008). Behavioral intention can be used to categorize citizens into those who are truly committed to environmental protection, and those who are willing to sacrifice purely financially for the sake of the environment (Nawrotzki, 2012). In this case, behavioral intention demonstrates an individual's readiness to behave in a specified way, and it is regarded as the direct antecedent of actual behavior. Behavioral intention, with the perceived need for risk mitigation, depends on the level of urgency of the danger or risk (Lo, 2014). Individuals' behavioral intention is often distinguished by environmental citizenship behavior and willingness to sacrifice economically for environmental causes (Dietz et al., 1998; Stern et al., 1999; Wakefield et al., 2006).

Individuals' willingness to sacrifice is driven by socioeconomic, psychological, individual, social, and institutional factors (Blankenberg and Alhusen, 2018). Pro-environmental behavioral intention—the willingness to make sacrifices for the sake of the environment— should not only be understood in terms of citizens' commitment to environmental protection, but also in the context of money they have available to spend (e.g., possible restrictions and low-income levels in poor societies) and their distrust in political institutions (Harring, 2013; Meyer and Liebe, 2010). In an earlier study, readiness to make sacrifices was found to be crucial for engaging in sustainable consumption behavior (Hadler and Haller, 2011).

We link individuals' behavioral intention to their willingness to make sacrifices, which can also be regarded as a manifestation of their support for environmental policies. We formulate H8 as a direct hypothesis by applying a segmentation approach (Memon et al., 2018):

H8. *Higher levels of behavioral intention lead to increased sustainable consumption behavior.*

2.6. Theoretical model

Based on the hypotheses, we have created a theoretical model for exploring the influence of environmental concern that results from environmental knowledge and risk perception on behavioral intention, which, in turn, acts as a mediator of sustainable consumption behavior. The directions of the paths are based on the theoretical background described above (Fig. 1).

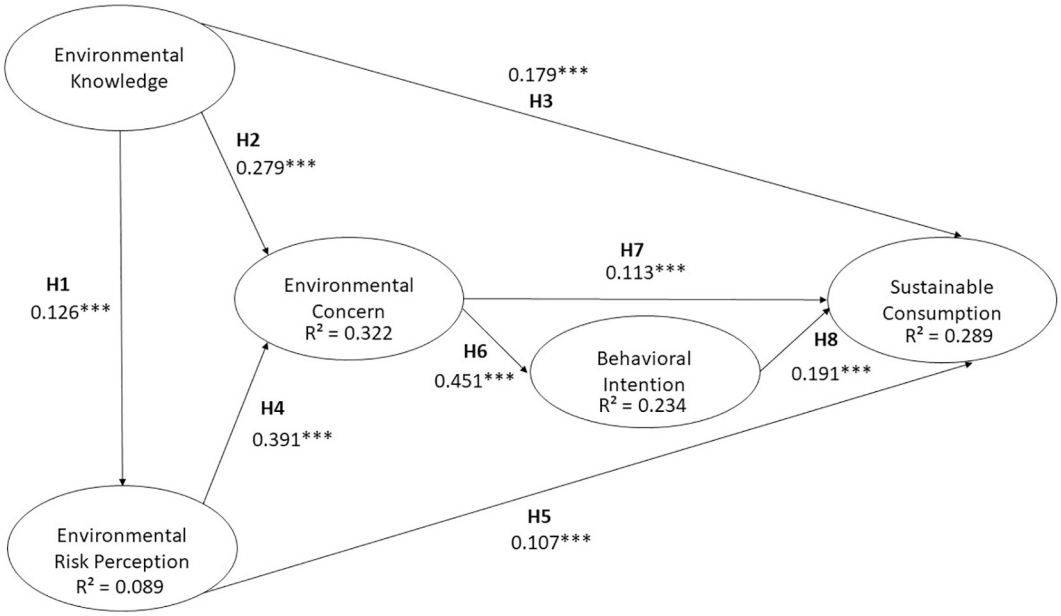

Fig. 1. Theoretical model and results, in which gender, age, degree, and countries have been considered as control variables.
Note: *** = $p < 0.01$.

3. Operationalization, data, and methodology

3.1. Operationalization of the measurement models

All constructs of our model (Fig. 1) are estimated by using multiple items (Table 1) in reflective measurement models (Sarstedt et al., 2016). The selection of items for each measurement model follows the theoretical considerations and empirical substantiations presented in prior publications. In this paper, the measurement of the constructs of environmental knowledge and environmental concern is based on the operationalization applied and validated by Vainio and Paloniemi (2014), while the environmental risk perception construct is based on the research conducted by Marquart-Pyatt (2015). The latent measure of environmental risk perception utilized by Marquart-Pyatt (2015) has been tested across 32 countries and proven to be reliable and valid. Behavioral intention is operationalized based on research by Lo (2016) and Marquart-Pyatt (2008). Sustainable consumption behavior, which is the dependent variable, is measured using a construct operationalized and validated by Wang (2017).

The environmental knowledge construct (Vainio and Paloniemi, 2014) includes three items measuring how much respondents feel they know about the causes of environmental problems and the corresponding solutions. We have extended the construct by one item to measure the extent of knowledge that the respondents feel they have on the impact of their personal lifestyle on the environment, which is in line with the definition of Vainio and Paloniemi (2014) of the 'perceived knowledge of environmental problems.' The three underlying items of the risk perception construct (Marquart-Pyatt, 2015) are the respondents' perceptions of the dangers of the air pollution that is emitted by cars and by industry, and the rise in the world's temperature. To measure the environmental concern of respondents, four items have been used (Vainio and Paloniemi, 2014). Three of these items measure the extent to which respondents agree or disagree that people worry too much about the future of the environment and not enough about prices and jobs, that people worry too much about harming the environment, and that many claims about the environment are exaggerated; the fourth item is a global item on environmental concern. The second mediator consists of items regarding behavioral intention toward protecting the environment, such as paying higher prices, paying higher taxes, accepting cuts in the standard of living, and spending more time and/or money (Lo, 2016; Marquart-Pyatt, 2008). The target construct, sustainable consumption behavior, includes four items: making special efforts in terms of buying fruits and vegetables without chemicals, reducing energy, reusing water, and avoiding the purchase of specified products (Wang, 2017).

3.2. Data

In this study, we use the ISSP Environment III open data set, which was collected between 2009 and 2013 by the International Social Survey Programme (ISSP) via local research institutes, using face-to-face interviews, self-completion questionnaires, and a mixed-method approach (ISSP Research Group, 2012). The data set was collected in 36 countries, including the nine European countries that we used in our study (N = 11,675).[2] The data from these countries were collected between 2010 and 2011. The ISSP data set, which was collected in the EU and EFTA countries, enables us to measure baseline levels for the constructs in our model, which are used to explore patterns of sustainable consumption behavior on a European scale 20 years after the establishment of the EEA.

Following Hair et al. (2022), we removed the observations with more than 15% missing values; therefore, we deleted the cases in which the respondent did not answer at least 15 out of our 17 questions. The final dataset includes 11,675 responses, while the number of missing values does not exceed 3.9% per variable. To treat the missing data, we used the expectation-maximization method, which is a powerful tool for handling predicted values, and a suitable approach for dealing with incomplete data (Dempster et al., 1977; Schafer and Olsen, 1998). Table A.1 (Appendix) presents the demographic information of the sample.

3.3. Method

To evaluate our theoretical model (Fig. 1), we used the PLS-SEM method (Lohmöller, 1989; Sarstedt et al., 2017; Wold, 1982). This

[2] The following countries are included in our analysis: Austria (N = 980), Czech Republic (N = 1381), Denmark (N = 1186), Finland (N = 1113), France (N = 2033), Germany (N = 1289), Netherlands (N = 1296), Norway (N = 1286), Sweden (N = 1111).

Table 1
Measurement items for the constructs in the theoretical model.

Constructs	Measurement items	Sources
Environmental Knowledge	V18: How much do you feel you know about the causes of these sorts of environmental problems? V19: How much do you feel you know about solutions to these sorts of environmental problems? V37: How much do you agree or disagree with…: I find it hard to know whether the way I live is helpful or harmful to the environment.	Vainio and Paloniemi (2014)
Environmental Risk Perception	*In general, do you think that … is…?* V39: Air pollution caused by cars. V40: Air pollution caused by industry. V43: Rise in the world's temperature caused by climate change.	Marquart-Pyatt (2015)
Environmental Concern	V15: Generally speaking, how concerned are you about environmental issues? *And how much do you agree or disagree with each of these statements?* V23: We worry too much about the future of the environment and not enough about prices and jobs. V25: People worry too much about human progress harming the environment. V36: Many of the claims about environmental threats are exaggerated.	Vainio and Paloniemi (2014)
Behavioral Intention	*How willing would you be to…to protect the environment?* V29: Pay much higher prices. V30: Pay much higher taxes. V31: Accept cuts in your standard of living.	Lo (2016), Marquart-Pyatt (2008)
Sustainable Consumption Behavior	*How often do you… (for environmental reasons)?* V56: Make a special effort to buy fruit and vegetables grown without pesticides or chemicals. V58: Reduce the energy or fuel you use at home. V59: Choose to save or re-use water. V60: Avoid buying certain products.	Wang (2017)

All items were measured on a 5-point Likert scale except the items of sustainable consumption behavior, which were measured on a 4-point scale. We reverse-coded the following items to show the same direction of effects: V29–31, V39-V43, and V56-V60. The original scale ranged from 1 (highest response) to 5 (lowest response).

multivariate data analysis method is well-established in the social and behavioral sciences (Hair et al., 2019), including knowledge management (Cepeda-Carrión et al., 2019), information systems research (Roldán and Sánchez-Franco, 2012), and general management research (Richter et al., 2016). PLS-SEM is a particularly suitable technique for measuring environmental concern and has been used in previous sustainable consumption behavior studies (Antonetti and Maklan, 2014). Furthermore, PLS-SEM is an appropriate technique for prediction-oriented modeling purposes (Cepeda-Carrión et al., 2016), in which researchers typically focus on the target construct (Calvo-Mora et al., 2020). The PLS-SEM method is especially suitable for scenarios in which the underlying model is relatively complex, the analysis is concerned with testing a theoretical framework from a prediction perspective, the research is based on secondary data (Hair et al., 2019), and the primary objective is the explanation and prediction of target constructs (Hair et al., 2022).

In confirmatory research, the objective is to understand the causal relationships between theoretical constructs of interest by obtaining empirical evidence for the description of the operating mechanism. Confirmatory and explanatory research are often combined by testing the measurement models and focusing on the explanation of a specified construct in a structural model. PLS-SEM is a suitable approach for analyzing mediation effects (Cepeda-Carrión et al., 2017), especially when building more sophisticated models (Nitzl et al., 2016).

For the model estimation, we utilize the SmartPLS 3 software (Ringle et al., 2015). Significance testing applies the bootstrapping procedure with 10,000 samples, the percentile approach, and a two-tailed test. The assessment of the results begins with the measurement models and subsequently focuses on the structural model (Hair et al., 2019).

4. Empirical analysis

4.1. Assessment of the measurement models

To assess the measurement models, we follow Hair et al. (2022) and Hair et al. (2019). The assessment of reflective measurement models includes the analysis of indicator reliability, internal consistency (composite reliability and ρ_A), convergent validity (average variance extracted; AVE) and discriminant validity (heterotrait-monotrait ratio of correlations; HTMT). The indicator loadings reflect the amount of variance that is shared between the individual indicator variables and the associated construct, which is used to ensure indicator reliability. Except for two indicators, all of the indicator loadings in our reflective measurement models exceed the critical value of 0.70; thus, the model provides sufficient indicator reliability (Sarstedt et al., 2017). We retained those two items that had slightly smaller loadings (above 0.6) as they are also considered to be acceptable (Hair et al., 2022). Furthermore, an analysis of the additional evaluation criteria yielded satisfactory overall results for the data set (Table A.2).

The composite reliability and ρ_A support the assessment of the reflective construct's internal consistency reliability. The ρ_A criterion has satisfactory results for our reflective constructs (Table A.3), which lie between the thresholds of 0.70 and 0.95 (Hair et al., 2019). The value for environmental knowledge is slightly lower, but, looking at the composite reliability, we assume this value also to be satisfactory. The AVE enables us to assess the reflective construct's convergent validity. With regards to convergent validity, all reflective constructs' AVE values in our model exceed the critical value of 0.5 (Table A.3).

Finally, to ensure discriminant validity, the distinctiveness of a construct is measured with the HTMT ratio of correlations (Henseler et al., 2015). Discriminant validity has been established in our model, since all HTMT values are significantly below (one-tailed test, $p < 0.05$) the more conservative cut-off value of 0.85 (Table A.4).

4.2. Assessment of the structural model

To assess the structural model, we follow Hair et al. (2019, 2022). The assessment of the structural model involves checking collinearity issues with the variance inflation factor (VIF), the significance and relevance of the path coefficients in the model, and the models' explanatory and predictive power (Hair et al., 2020). We find that the largest inner VIF is 1.686, hence, collinearity is not at a critical level.

Next, we examine the size and significance of the path coefficients (ß), tabulating the results in line with Buitrago et al. (2018) and Ghasemy et al. (2020). All the path coefficients in the structural model are statistically significant ($p < 0.01$) and have low f^2 effect sizes (Table

A.5). As illustrated by the path between environmental knowledge and risk perception (ß = 0.126) in Fig. 1, higher levels of environmental knowledge lead to higher levels of risk perception. Furthermore, environmental knowledge (ß = 0.279) and risk perception (ß = 0.391) are important in explaining environmental concern ($R^2 = 0.322$), which, in turn, explains behavioral intention ($R^2 = 0.234$) with a path coefficient of ß = 0.451. Finally, environmental knowledge (ß = 0.179), risk perception (ß = 0.107), environmental concern (ß = 0.113), and behavioral intention (ß = 0.191) differ in terms of strength in explaining the key target construct, sustainable consumption behavior ($R^2 = 0.289$).

To ensure that the estimated coefficients are not affected by endogeneity issues, we applied the Gaussian copula approach (Park and Gupta, 2012). In the model, we focus on the relationships of environmental knowledge, risk perception, environmental concern, and behavioral intention on the key target construct, sustainable consumption behavior. This Gaussian copula approach requires that the independent variables, which are potentially affected by endogeneity problems, are non-normally distributed. Both the Kolmogorov-Smirnov test with Lilliefors correction and the Shapiro-Wilk test substantiate that environmental knowledge, risk perception, environmental concern, and behavioral intention have a non-normal distribution ($p < 0.01$). On these grounds, we use the REndo package of the statistical software R (Gui et al., 2017) to run the Gaussian copula analysis in PLS-SEM as described by Hult et al. (2018). The results in Table 2 show that none of the copula terms are significant at the 1% probability of error level. Only the copula term of environmental knowledge is significant at the 5% probability of error level. However, the path coefficient from environmental knowledge to sustainable concern changes only by 0.069 in the Gaussian copula model. This also represents the highest change of a coefficient. Hence, we conclude that the PLS-SEM results are robust and not substantially affected by potential endogeneity issues.

The procedure for evaluating the mediating effects in PLS-SEM considers several important criteria. First, it involves assessing the indirect effects. Then, the strength and significance are assessed by using the bootstrapping procedure, and the significance and direction of the direct effects are considered to determine the type of mediation (Cepeda-Carrión et al., 2017). In our study, the serial mediation model is a case of complementary partial mediation, as both the direct and indirect effects (Table A.5) are significant and point in the same direction. The total effects are presented in Table A.6. With regards to the indirect effects of our serial mediation model, we established that environmental concern has the largest effect (ß = 0.086) on sustainable consumption behavior via behavioral intention, whereas environmental knowledge (ß = 0.024) and environmental risk perception (ß = 0.034) have smaller effects via the mediators environmental concern and behavioral intention (Table A.5).

Table 2
Gaussian copula results.

Variable	Original model		Gaussian Copula Results		Difference of β
	β	*p* value	β	*p* value	
Environmental Knowledge (EK)	0.179	0.000	0.110	0.000	0.069
Environmental Risk Perception (RP)	0.107	0.000	0.123	0.000	−0.016
Environmental Concern (EC)	0.113	0.000	0.098	0.010	0.015
Behavioral Intention (BI)	0.191	0.000	0.147	0.000	0.044
Age	0.153	0.000	0.153	0.000	0.000
Country	0.299	0.000	0.299	0.000	0.000
Education	−0.039	0.000	−0.039	0.000	0.000
Gender	0.090	0.000	0.091	0.000	−0.001
Gaussian copula term for EK			0.064	0.022	
Gaussian copula for term RP			−0.014	0.343	
Gaussian copula for term EC			0.016	0.650	
Gaussian copula for term BI			0.042	0.054	

Since the R^2 statistics only indicate a model's in-sample explanatory power, we also applied $PLS_{predict}$ (Danks and Ray, 2018; Shmueli et al., 2019) to assess the out-of-sample predictive relevance of our model for sustainable consumption behavior (Shmueli et al., 2019). The results show that the $Q^2_{predict}$ values are above zero (Table A.8). Next, we compare the RMSE values that were obtained via PLS-SEM with the linear model (LM) benchmark, since the prediction errors in our model are symmetrically distributed. The majority of $RMSE_{PLS}$ values are lower than the $RMSE_{LM}$ values on an indicator level (Table A.8). Consequently, the model has medium to high predictive power for the key target construct sustainable consumption behavior (Hair et al., 2019).

In order to further substantiate our findings, we controlled for age, gender, education, and country (Table A.5). Regarding environmental concern and attitudes, women have often indicated stronger environmental attitudes, concern and behavior than men (e.g. Gifford and Nilsson, 2014; Tikka et al., 2000). Some research also indicates that younger people tend to show higher levels of environmental concern than older people, even though older generations can display more sustainable consumption behavior (Casey and Scott, 2006; Gifford and Nilsson, 2014). Environmental education attempts to motivate citizens by appealing to their altruistic desires to act in morally correct ways to follow a green or pro-environmental lifestyle instead of overconsuming and damaging the environment (Gibson et al., 2011). The provision of education and information on environmental issues and presenting possible solutions to consumers have been regarded as the key to having a positive impact on consumer behavior (Marquart-Pyatt, 2008; Owens, 2000). Furthermore, although environmental risk perception is comparable across countries, the level of risk perception can vary due to different kinds of social, political, and cultural circumstances (Bickerstaff, 2004; Marquart-Pyatt, 2012).

We control the PLS-SEM results for age, country, education, and gender. Gender serves as a dummy-coded control variable (0 = male and 1 = female) and we use age as a continuous control variable, with the youngest respondent being 15 years old and the oldest 98 years old. Both control variables are included as single-item constructs in the PLS path model. We also included the country control variable in the PLS path model by following the recommendations of Hair et al. (2022). More specifically, the country control construct consists of seven dummy-coded indicators, each representing a different country. The eighth country in our study (i.e., Sweden), results as a complement to the dummy indicators of the other countries and serves as a reference category. Similarly, we generated the education control variable with the five dummy coded indicators representing low degree, intermediate degree, high degree, university degree incomplete, and university degree completed. Here, no degree (i.e., no formal qualification) serves as reference category. Table A.5 shows the specific results of these four control variables (i.e., age, country, education, and gender) and, in addition, Table A.7 shows the total effects of each country and each education control indicator on the target constructs.

5. Discussion and implications

5.1. Theoretical implications

Our research indicates that environmental knowledge influences environmental risk perception, and that both have an impact on environmental concern, but that the path from risk perception is stronger. Furthermore, while environmental knowledge and risk perception both have a direct effect on sustainable consumption behavior, the path from environmental knowledge has a higher impact. Environmental concern

is shown to strongly influence behavioral intention, which further mediates sustainable consumption behavior, but it also has a direct effect on the target construct.

Environmental knowledge is the most important variable to predict sustainable consumption behavior. This finding is in line with recent research on the roles of motives and knowledge in individuals' intention to adopt and apply environmental behavior (Gkargkavouzi et al., 2019). It is reinforced by the finding of Meyer (2015) that a higher level of environmental knowledge positively impacts pro-environmental behavior. Similar findings on the importance of environmental knowledge and risk perception have been reported by earlier studies, which show that individuals with knowledge about environmental issues tend to have a more positive attitude toward the protection of the environment (Marquart-Pyatt, 2008; O'Connor et al., 1999) and show an increased likelihood of sustainable consumption behavior (Fraj-Andrés and Martínez-Salinas, 2007; Hines et al., 1987; Macias, 2015). Even though individuals might knowingly engage in unsustainable activities, they behave based on their knowledge about the possible damaging effects of their behavior.

According to our findings, risk perception is also important in explaining sustainable consumption behavior. This is in line with previous studies indicating that, in particular, the feeling of risk causes emotional responses to the state of the environment and its degradation, which in turn can result in strong commitment to environmental causes on the individual level (Chawla, 1999; Wang, 2017). This was also observed in cross-national studies globally, indicating that the perception of environmental risks can have an influence on attitudes and behavior (Dunlap and York, 2008; Franzen and Meyer, 2010; Hadler and Haller, 2013).

Previous studies have also identified the mediating effect of environmental concern on factors that impact sustainable and pro-environmental behavior (e.g., Coelho et al., 2017). According to a rationalist perspective, individuals calculate the costs and benefits of their actions from a self-interested perspective, and sustainable behavior is not always regarded as beneficial to the individual (Menzel, 2013). The self-interest of individuals has also been found to have stronger impacts on energy saving behaviors and electricity usage than environmental concern; however, in that particular study, environmental concern was measured by two statements regarding the environmental effects of electrical power plants and a general concern regarding the long-term effects of climate change (Ohler and Billger, 2014). In our study, environmental concern is measured by four items, which are all related to concerns regarding harmful impacts on the environment as well as a global concern, which together contribute to a wider and more general understanding of the level of environmental concern of the respondents. In the tested model, environmental knowledge and risk perception act as antecedents of environmental concern, which influences behavioral intention more than actual sustainable consumption behavior.

5.2. Practical implications

To identify the constructs' impact and performance on the target construct, we conducted an importance-performance map analysis (IPMA) with sustainable consumption behavior as the target variable (Table A.9; Fig. 2). The IPMA results demonstrate for which exogenous variable the total effects are important by explaining the endogenous target construct's variance (Hair et al., 2018; Ringle and Sarstedt, 2016). This method identifies the variables on which governments in EU and EFTA countries should focus when aiming at improving the performance of their citizens' sustainable consumption behavior. In this study, the IPMA results demonstrate differences between the drivers for sustainable consumption behavior (Table A.9). The results show that environmental risk perception (0.229) and environmental knowledge (0.196) have the largest total effects and are important in explaining sustainable consumption behavior (performance risk perception: 64.018 and performance environmental knowledge: 53.124). Environmental concern has a smaller total effect (0.167) and realizes moderate performance in comparison to the other two constructs (57.197). Finally, behavioral intention has the smallest total effect (0.122), and its performance is the weakest (43.870).

Based on the IPMA results, we recommend that decision and policy makers attempt to deliver more factual information based on scientific research regarding the ways in which production and consumption impact the environment and on the risks to the environment. Since our findings demonstrate that environmental knowledge plays an important role in predicting sustainable consumption behavior, this should be further addressed by policies and environmental education initiatives. Therefore, environmental campaigns and education material should refer to the gravity of the current environmental risks. This approach could result in a level of environmental concern that has a significant effect on sustainable consumption behavior. It could further facilitate

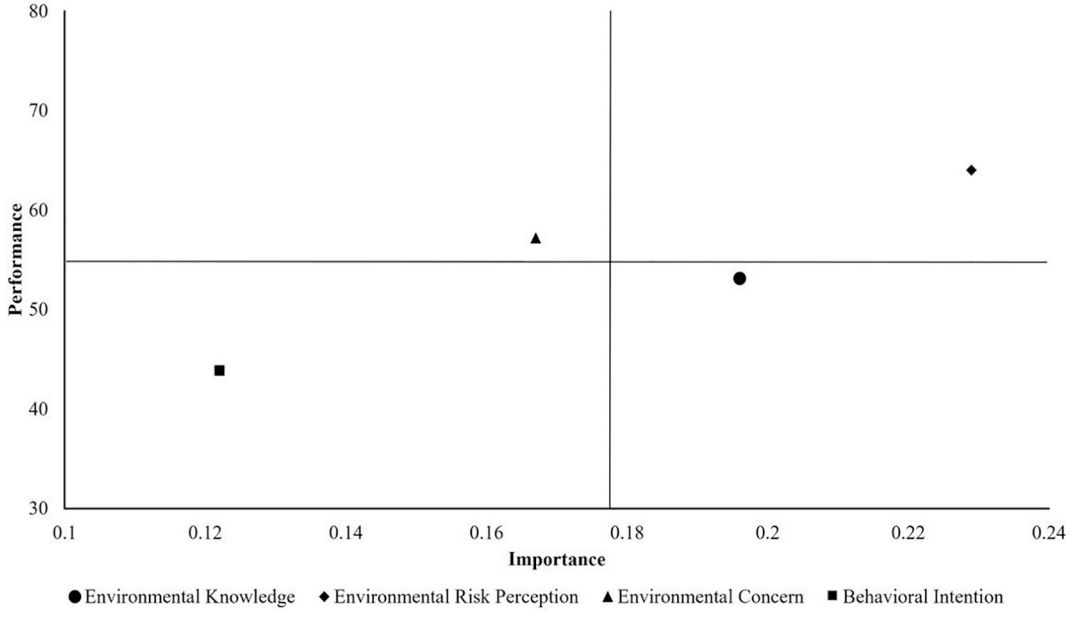

Fig. 2. Importance-performance map analysis (IPMA) results.

the promotion of sustainable consumption practices and enable the transition to a circular economy (Korhonen et al., 2018) by supporting the implementation of the Circular Economy Action Plan in the EU (European Commission, 2020).

6. Conclusions

The objective of this study was to develop a novel model with constructs that have been validated in earlier research, which had not previously been combined into a single model. Various factors, such as environmental risk perception and environmental knowledge, can influence environmental concern (Marquart-Pyatt, 2015; Vainio and Paloniemi, 2014), which, in turn, can impact sustainable consumption behavior. According to our model and results, environmental concern can even act as a mediator of behavioral intention (Lo, 2016; Marquart-Pyatt, 2008), which further influences sustainable consumption behavior (Wang, 2017).

The main contribution of this study is the development and validation of a novel model based on a large open data set, the ISSP Environment III data set, which has 50,437 respondents ($N = 11{,}675$ for our final EU data set). Moreover, this study is among the first studies to use the PLS-SEM approach to investigate the complex influences between environmental knowledge and environmental risk perception on sustainable consumption behavior in EU and EFTA countries. Due to the complexity of the relationship between environmental concern and sustainable consumption behavior (Dunlap, 2017), our model includes the mediating effect of behavioral intention (Nauges and Wheeler, 2017).

In light of the latest developments regarding the promotion of sustainable production and consumption and with the introduction of the Climate Action Plan and the Green Deal on the EU level, understanding the factors that can influence sustainable consumption behavior among Europeans in EU and EFTA countries is crucial for policy makers. By focusing on environmental knowledge and risk perception, we concentrate on factors that can be externally influenced by future policies and environmental education.

Nevertheless, our model has its limitations: One of the foci in this paper has been on studying the nature of environmental concern, and, for this reason, the model focuses on factors impacting environmental concern. However, future studies could also consider reversing the constructs of knowledge about environmental issues and environmental concern in our hypothesis (*H2: Enhanced knowledge about environmental issues leads to increased levels of environmental concern)*. Moreover, future studies could investigate the level to which environmental concern could influence and increase the motivation to acquire more knowledge about environmental issues, since increased levels of environmental concern in itself does not directly lead to enhanced knowledge about environmental issues.

Altogether, there is a growing need to create integrative frameworks that address socio-economic, psychological, individual, social, and institutional factors (Blankenberg and Alhusen, 2018; Geels et al., 2015). While this research paper has focused on establishing a European-wide model for explaining sustainable consumption behavior under EU legislation, future studies could compare individual countries within the EU. Although we have used constructs that have been tested and proven to be valid and reliable, some of the constructs might be biased and represent the attitudes of wealthy, industrialized countries. For example, the construct behavioral intention, which includes willingness-to-sacrifice attitudes, could be biased, since wealthier individuals are better able to afford eco-friendly products and solutions than poorer people, even though these consumer groups' level of environmental concern could be the same (Dunlap and York, 2008). Moreover, environmental knowledge, risk perception, and sustainable consumption behavior seem to vary with income (Lo, 2014) and location (Marquart-Pyatt, 2015). The between-country heterogeneity could be explored and analyzed in more detail to evaluate country-specific policies in addition to EU-level policies.

Furthermore, future studies could examine other factors that influence sustainable consumption behavior, such as the influence of social media. The attitudes of individual consumers toward sustainable consumption behavior should be well understood when promoting sustainable consumption. In addition, the roles of institutional factors must be examined to identify the societal drivers and barriers to enforce the implementation of more sustainable consumption behavior among citizens in various countries and regions (Peattie, 2010; Spaargaren and Oosterveer, 2010; Wang, 2017). The influence of trust and the price that must be paid by individuals for behaving in an eco-friendly manner should also be examined in future research (OECD, 2014). Considering the ongoing discussion on sustainability and sustainable consumption behavior, it is crucial for future studies to analyze the forthcoming ISSP Environment IV data set (estimated to be published in 2022) with our model to evaluate its generalizability and to compare current results to those obtained from the newest data set. Based on the Environment IV Final Source Questionnaire, the forthcoming ISSP Environment IV data set includes approximately the same set of questions that were used in this study (ISSP, 2020). In addition, there are questions that focus more on the consumption of meat, the size of living spaces, and the use of motorized vehicles. The questions on the level of environmental knowledge are refined to focus more on the understanding of the harmfulness of living habits (ISSP, 2020). Via this approach, additional conclusions and recommendations for policies can be further substantiated.

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Data availability

The data directly supporting the study results can be found on the website of GESIS supporting the ISSP Research Group, under ZA5500: International Social Survey Programme: Environment III - ISSP 2010, https://www.gesis.org/issp/modules/issp-modules-by-topic/environment/2010/.

Declaration of Competing Interest

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

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Appendix A

Table A.1. Demographic data.

Country	N	Gender	%
Overall	11,675	Male	48.8
		Female	51.2
Austria	980	Male	47.4
		Female	52.6
Czech Republic	1381	Male	47.9
		Female	52.1
Denmark	1186	Male	47.2
		Female	52.8
Finland	1113	Male	44.7
		Female	55.3
France	2033	Male	54.9
		Female	45.1
Germany	1289	Male	47.8
		Female	52.2
Netherlands	1296	Male	46.0
		Female	54.0
Norway	1286	Male	50.9
		Female	49.1
Sweden	1111	Male	47.4
		Female	52.6

Table A.2. Indicator loadings.

Construct	Item	Loading
Environmental Knowledge	V18	0.844
	V19	0.826
	V37	0.659
Environmental Concern	V15	0.719
	V23	0.724
	V25	0.673
	V36	0.790
Environmental Risk Perception	V39R	0.808
	V40R	0.753
	V43R	0.817
Sustainable Consumption Behavior	V56R	0.737
	V58R	0.724
	V59R	0.702
	V60R	0.840
Behavioral Intention	V29R	0.884
	V30R	0.864
	V31R	0.848

Table A.3. Reliability and validity.

	ρ_A	Composite Reliability	Average Variance Extracted
Environmental Knowledge	0.673	0.823	0.611
Environmental Risk Perception	0.731	0.836	0.629
Environmental Concern	0.719	0.818	0.529
Behavioral Intention	0.837	0.899	0.749
Sustainable Consumption Behavior	0.769	0.839	0.566

Table A.4. Heterotrait-monotrait (HTMT) ratio of correlations.

	Environmental Knowledge	Risk Perception	Environmental Concern	Behavioral Intention
Risk Perception	0.145			
	$CI_{95} = 0.169$			
Environmental Concern	0.498	0.582		
	$CI_{95} = 0.518$	$CI_{95} = 0.601$		
Behavioral Intention	0.301	0.296	0.592	
	$CI_{95} = 0.320$	$CI_{95} = 0.316$	$CI_{95} = 0.608$	
Sustainable Consumption Behavior	0.323	0.361	0.396	0.363
	$CI_{95} = 0.344$	$CI_{95} = 0.381$	$CI_{95} = 0.416$	$CI_{95} = 0.381$

The table displays the results of the HTMT criterion; CI_{95} = Upper bound of the one-sided 95% percentile bootstrap confidence interval.

Table A.5. Structural model results.

Outcome	Predictor	Direct Paths & Hypotheses	β	CI	Significance?	f^2	VIF
EK ($R^2 = 0.075$)	CV	Gender ➔ EK	−0.110	[−0.128; −0.092]	Yes	0.013	1.003
	CV	Age ➔ EK	−0.009	[−0.027; 0.009]	No	0.000	1.022
	CV	Degree ➔ EK	0.248	[0.299; 0.267]	Yes	0.064	1.045
	CV	Countries ➔ EK	−0.017	[−0.046; 0.015]	No	0.000	1.037
RP ($R^2 = 0.089$)	EK	H1(+): EK ➔ RP	0.126	[0.109; 0.142]	Yes	0.016	1.081
	CV	Gender ➔ RP	0.150	[0.133; 0.167]	Yes	0.024	1.016
	CV	Age ➔ RP	−0.139	[−0.157; −0.121]	Yes	0.021	1.022
	CV	Degree ➔ RP	−0.006	[−0.028; 0.015]	No	0.000	1.111
	CV	Countries ➔ RP	0.202	[0.163; 0.228]	Yes	0.043	1.037
EC ($R^2 = 0.322$)	EK	H2(+): EK ➔ EC	0.279	[0.265; 0.294]	Yes	0.105	1.099
	RP	H4(+): RP ➔ EC	0.391	[0.376; 0.406]	Yes	0.206	1.097
	CV	Gender ➔ EC	0.108	[0.093; 0.123]	Yes	0.017	1.041
	CV	Age ➔ EC	0.003	[−0.013; 0.018]	No	0.000	1.043
	CV	Degree ➔ EC	0.165	[0.147; 0.182]	Yes	0.036	1.111
	CV	Countries ➔ EC	0.004	[−0.041; 0.054]	No	0.000	1.082
BI ($R^2 = 0.234$)	EC	H6(+): EC ➔ BI	0.451	[0.437; 0.464]	Yes	0.244	1.091
	CV	Gender ➔ BI	−0.020	[−0.036; −0.003]	Yes	0.001	1.022
	CV	Age ➔ BI	0.058	[0.042; 0.075]	Yes	0.004	1.025
	CV	Degree ➔ BI	0.104	[0.083; 0.124]	Yes	0.013	1.110
	CV	Countries ➔ BI	−0.039	[−0.087; 0.019]	No	0.002	1.044
SC ($R^2 = 0.289$)	EK	H3(+): EK ➔ SC	0.179	[0.164; 0.194]	Yes	0.037	1.218
	RP	H5(+): RP ➔ SC	0.107	[0.090; 0.128]	Yes	0.012	1.331
	EC	H7(+): EC ➔ SC	0.113	[0.094; 0.132]	Yes	0.011	1.686
	BI	H8(+): BI ➔ SC	0.191	[0.170; 0.210]	Yes	0.039	1.317
	CV	Gender ➔ SC	0.090	[0.074; 0.106]	Yes	0.011	1.059
	CV	Age ➔ SC	0.153	[0.138; 0.170]	Yes	0.032	1.049
	CV	Degree ➔ SC	−0.039	[−0.058; −0.021]	Yes	0.002	1.165
	CV	Countries ➔ SC	0.299	[0.275; 0.315]	Yes	0.116	1.085
		EK ➔ RP ➔ SC	0.013	[0.011; 0.017]	Yes		
		EK ➔ RP ➔ EC ➔ SC	0.006	[0.004; 0.007]	Yes		
		EK ➔ RP ➔ EC ➔ BI ➔ SC	0.004	[0.003: 0.005]	Yes		
		EK ➔ EC ➔ SC	0.032	[0.026; 0.037]	Yes		
		EK ➔ EC ➔ BI ➔ SC	0.024	[0.021; 0.027]	Yes		
		RP ➔ EC ➔ SC	0.044	[0.036; 0.052]	Yes		
		RP ➔ EC ➔ BI ➔ SC	0.034	[0.029; 0.038]	Yes		
		EC ➔ BI ➔ SC	0.086	[0.076; 0.095]	Yes		

CI = 95% bootstrap confidence interval, CV = control variable, EK = environmental knowledge, RP = risk perception, EC = environmental concern, BI = behavioral intention, SC = sustainable consumption behavior. The path coefficients were calculated with a one-tailed and the controls with a two-tailed test.

Table A.6. Total effects.

	ß	CI	Significance?
Knowledge ➔ Sustainable Consumption Behavior	0.243	[0.229; 0.257]	Yes
Risk Perception ➔ Sustainable Consumption Behavior	0.206	[0.192; 0.220]	Yes
Environmental Concern ➔ Sustainable Consumption Behavior	0.179	[0.163; 0.196]	Yes

CI = 95% bootstrap confidence interval.

Table A.7. Total effects of the indicators on the target constructs.

Country	Environmental Knowledge	Risk Perception	Environmental Concern	Behavioral Intention	Sustainable Consumption
Austria	−0.0074	0.0885	0.0018	−0.0171	0.1310
Czech	−0.0019	0.0224	0.0004	−0.0043	0.0332
Denmark	−0.0039	0.0459	0.0009	−0.0089	0.0679
Finland	−0.0011	0.0131	0.0003	−0.0025	0.0194
France	−0.0115	0.1372	0.0027	−0.0265	0.2030
Germany	−0.0103	0.1218	0.0024	−0.0235	0.1803
Netherlands	0.0010	−0.0115	−0.0002	0.0022	−0.0170
Norway	0.0064	−0.0755	−0.0015	0.0146	−0.1118
Education	Environmental Knowledge	Risk Perception	Environmental Concern	Behavioral Intention	Sustainable Consumption
University degree complete	0.2847	−0.0069	0.1894	0.1194	−0.0448
University degree incomplete	0.1652	−0.0040	0.1099	0.0693	−0.0260
High degree	0.1123	−0.0027	0.0747	0.0471	−0.0177
Intermediate degree	0.0474	−0.0011	0.0315	0.0199	−0.0074
Low degree	−0.0020	0.0000	−0.0013	−0.0008	0.0003

Sweden serves as reference country for the country control variable; no degree (i.e., no formal qualification) serves as the reference education level for the control variable education.

Table A.8. PLSpredict analysis results.

Construct	Indicator	PLS		LM	PLS-LM
		RMSE	$Q^2_{predict}$	RMSE	RMSE
Sustainable Consumption	V56	0.8727	0.0269	0.8728	−0.001
	V58	0.8687	0.0274	0.8689	−0.002
	V59	0.9450	0.0166	0.9445	0.005
	V60	0.8252	0.0507	0.8246	0.006

Table A.9. Importance-performance map analysis (IPMA) results.

IPMA (on Sustainable Consumption Behavior)	Unstandardized Total Effect	Performance
Environmental Knowledge	0.196	53.124
Environmental Risk Perception	0.229	64.018
Environmental Concern	0.167	57.197
Behavioral Intention	0.122	43.870

References

Ajzen, I., 1991. The theory of planned behavior. Organ. Behav. Hum. Decis. Process. 50, 179–211. https://doi.org/10.1016/0749-5978(91)90020-T.

Aldrich, G.A., Grimsrud, K.M., Thacher, J.A., Kotchen, M.J., 2007. Relating environmental attitudes and contingent values: how robust are methods for identifying preference heterogeneity? Environ. Resour. Econ. 37, 757–775. https://doi.org/10.1007/s10640-006-9054-7.

Antonetti, P., Maklan, S., 2014. Feelings that make a difference: how guilt and pride convince consumers of the effectiveness of sustainable consumption choices. J. Bus. Ethics 124, 117–134. https://doi.org/10.1007/s10551-013-1841-9.

Arbuthnot, J., Lingg, S., 1975. A comparison of French and American environmental behaviors, knowledge, and attitudes 1 2. Int. J. Psychol. 10, 275–281. https://doi.org/10.1080/00207597508247339.

Ari, E., Yilmaz, V., 2016. A proposed structural model for housewives' recycling behavior: a case study from Turkey. Ecol. Econ. 129, 132–142. https://doi.org/10.1016/j.ecolecon.2016.06.002.

Balžekiene, A., Telešiene, A., 2017. Vulnerable and insecure? Environmental and technological risk perception in Europe. In: Telesiene, A., Gross, M. (Eds.), Green European: Environmental Behaviour and Attitudes in Europe in a Historical and Cross-Cultural Comparative Perspective. Routledge, London, pp. 31–55.

Bamberg, S., 2003. How does environmental concern influence specific environmentally related behaviors? A new answer to an old question. J. Environ. Psychol. 23, 21–32. https://doi.org/10.1016/S0272-4944(02)00078-6.

Bang, H., Ellinger, A., Hadjimarcou, J., Traichal, P., 2000. Consumer concern, knowledge, belief, and attitude toward renewable energy: an application of the reasoned action theory. Psychol. Mark. 17, 449–468. https://doi.org/10.1002/(SICI)1520-6793(200006)17:6<449::AID-MAR2>3.0.CO;2-8.

Baumgärtner, S., Quaas, M., 2010. What is sustainability economics? Ecol. Econ. 69, 445–450. https://doi.org/10.1016/j.ecolecon.2009.11.019.

Bickerstaff, K., 2004. Risk perception research: socio-cultural perspectives on the public experience of air pollution. Environ. Int. 30, 827–840. https://doi.org/10.1016/j.envint.2003.12.001.

Bickerstaff, K., Walker, G., 2001. Public understandings of air pollution: the 'localisation' of environmental risk. Glob. Environ. Chang. 11, 133–145. https://doi.org/10.1016/S0959-3780(00)00063-7.

Blankenberg, A.K., Alhusen, H., 2018. On the Determinants of Pro-Environmental Behavior-A Guide for Further Investigations. University of Göttingen, Center for European, Governance and Economic Development Research (CEGE), Göttingen. http://wwwuser.gwdg.de/~cege/Diskussionspapiere/DP350.pdf.

Buitrago, E.M., Caraballo, M.Á., Roldán, J.L., 2018. Do tolerant societies demand better institutions? Soc. Indic. Res. 143 (3), 1161–1184. https://doi.org/10.1007/s11205-018-2002-4.

Butkeviciene, E., Morkevicius, V., 2017. Explaining membership in pro-environmental groups: A comparative European perspective. In: Telesiene, A., Gross, M. (Eds.), Green European: Environmental Behaviour and Attitudes in Europe in a Historical and Cross-Cultural Comparative Perspective. Routledge, London, pp. 111–132. https://www.taylorfrancis.com/chapters/edit/10.4324/9781315648491-18/explaining-membership-pro-environmental-groups-comparative-european-perspective-egl%C4%97-butkevi%C4%8Dien%C4%97-vaidas-morkevi%C4%8Dius.

Calvo-Mora, A., Blanco-Oliver, A., Roldán, J.L., Periáñez-Cristóbal, R., 2020. TQM factors and organisational results in the EFQM excellence model framework: an explanatory and predictive analysis. Ind. Manag. Data Syst. 120 (12), 2297–2317. https://doi.org/10.1108/IMDS-12-2019-0701.

Carrington, M.J., Neville, B.A., Whitwell, G.J., 2014. Lost in translation: exploring the ethical consumer intention–behavior gap. J. Bus. Res. 67, 2759–2767. https://doi.org/10.1016/j.jbusres.2012.09.022.

Casey, P.J., Scott, K., 2006. Environmental concern and behaviour in an Australian sample within an ecocentric-anthropocentric framework. Aust. J. Psychol. 58, 56–67. https://doi.org/10.1080/00049530600730419.

Cepeda-Carrión, G., Henseler, J., Ringle, C.M., Roldán, J.L., 2016. Prediction-oriented modeling in business research by means of PLS path modeling. J. Bus. Res. 69 (10), 4545–4551. https://doi.org/10.1016/j.jbusres.2016.03.048.

Cepeda-Carrión, G., Nitzl, C., Roldán, J.L., 2017. Mediation analyses in partial least squares structural equation modeling: Guidelines and empirical examples. In: Latan, H., Noonan, R. (Eds.), Partial Least Squares Path Modeling. Springer, Cham, pp. 173–195. https://link.springer.com/chapter/10.1007/978-3-319-64069-3_8.

Cepeda-Carrión, G., Cegarra-Navarro, J.-G., Cillo, V., 2019. Tips to use partial least squares structural equation modelling (PLS-SEM) in knowledge management. J. Knowl. Manag. 23 (1), 67–89. https://doi.org/10.1108/JKM-05-2018-0322.

Chawla, L., 1999. Life paths into effective environmental action. J. Environ. Educ. 31, 15–26. https://doi.org/10.1080/00958969909598628.

Choi, A., Fielding, K., 2013. Environmental attitudes as WTP predictors: a case study involving endangered species. Ecol. Econ. 89, 24–32. https://doi.org/10.1016/j.ecolecon.2013.01.027.

Coelho, F., Pereira, M., Cruz, L., Simões, P., Barata, E., 2017. Affect and the adoption of pro-environmental behaviour: a structural model. J. Environ. Psychol. 54, 127–138. https://doi.org/10.1016/j.jenvp.2017.10.008.

Cooper, P., Poe, G.L., Bateman, I.J., 2004. The structure of motivation for contingent values: a case study of lake water quality improvement. Ecol. Econ. 50, 69–82. https://doi.org/10.1016/j.ecolecon.2004.02.009.

Danks, N.P., Ray, S., 2018. Predictions from partial least squares models. In: Ali, F., Rasoolimanesh, S., Cobanoglu, C. (Eds.), Applying Partial Least Squares in Tourism and Hospitality Research (pp. 35-52). Emerald Publishing Limited. https://www.emerald.com/insight/content/doi/10.1108/978-1-78756-699-620181003/full/html.

Dempster, A.P., Laird, N.M., Rubin, D.B., 1977. Maximum likelihood from incomplete data via the EM algorithm. J. R. Stat. Soc.: B (Methodol.) 39, 1–22. https://doi.org/10.1111/j.2517-6161.1977.tb01600.x.

Dhandra, T.K., 2019. Achieving triple dividend through mindfulness: more sustainable consumption, less unsustainable consumption and more life satisfaction. Ecol. Econ. 161, 83–90. https://doi.org/10.1016/j.ecolecon.2019.03.021.

Dietz, T., Stern, P.C., Guagnano, G.A., 1998. Social structural and social psychological bases of environmental concern. Environ. Behav. 30, 450–471. https://doi.org/10.1177/001391659803000402.

Dunlap, R.E., 2017. A brief history of sociological research on environmental concern. In: Telesiene, A., Gross, M. (Eds.), Green European: Environmental Behaviour and Attitudes in Europe in a Historical and Cross-Cultural Comparative Perspective. Routledge, London, pp. xix–xxvi.

Dunlap, R.E., York, R., 2008. The globalization of environmental concern and the limits of the postmaterialist values explanation: evidence from four multinational surveys. Sociol. Q. 49, 529–563. https://doi.org/10.1111/j.1533-8525.2008.00127.x.

Eom, K., Kim, H.S., Sherman, D.K., Ishii, K., 2016. Cultural variability in the link between environmental concern and support for environmental action. Psychol. Sci. 27, 1331–1339. https://doi.org/10.1177/0956797616660078.

European Commission, 2019. The European Green Deal, Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions. https://ec.europa.eu/info/sites/info/files/european-green-deal-communication_en.pdf (Date accessed: 01.06.2020).

European Commission, 2020. EU Circular Economy Action Plan, for a Cleaner and More Competitive EUROPE. https://ec.europa.eu/environment/circular-economy/pdf/new_circular_economy_action_plan.pdf (Date accessed: 01.06.2020).
European Parliament, 2019. Environment Policy: General Principles and Basic Framework. Fact Sheets on the European Union. https://www.europarl.europa.eu/factsheets/en/sheet/71/vides-politika-visparigi-principi-un-pamatsistema (Date accessed: 01.06.2020).
Farjam, M., Nikolaychuk, O., Bravo, G., 2019. Experimental evidence of an environmental attitude-behavior gap in high-cost situations. Ecol. Econ. 166, 106434. https://doi.org/10.1016/j.ecolecon.2019.106434.
Fraj-Andrés, E., Martínez-Salinas, E., 2007. Impact of environmental knowledge on ecological consumer behaviour: an empirical analysis. J. Int. Consum. Mark. 19, 73–102. https://doi.org/10.1300/J046v19n03_05.
Franzen, A., Meyer, R., 2010. Environmental attitudes in cross-national perspective: a multilevel analysis of the ISSP 1993 and 2000. Eur. Sociol. Rev. 26, 219–234. https://doi.org/10.1093/esr/jcp018.
Franzen, A., Vogl, D., 2013. Two decades of measuring environmental attitudes: a comparative analysis of 33 countries. Glob. Environ. Chang. 23, 1001–1008. https://doi.org/10.1016/j.gloenvcha.2013.03.009.
Geels, F., McMeekin, A., Mylan, J., Southerton, D., 2015. A critical appraisal of sustainable consumption and production research: the reformist, revolutionary and reconfiguration positions. Glob. Environ. Change-Hum. Policy Dimens. 34, 1–12. https://doi.org/10.1016/j.gloenvcha.2015.04.013.
Gendall, P., 2012. International Social Survey Programme Study Monitoring 2010 Environment III. https://dbk.gesis.org.
Ghasemy, M., Mohajer, L., Cepeda-Carrión, G., Roldán, J.L., 2020. Job performance as a mediator between affective states and job satisfaction: a multigroup analysis based on gender in an academic environment. Curr. Psychol. 1–16. https://doi.org/10.1007/s12144-020-00649-9.
Gibson, C., Waitt, G., Head, L., Gill, N., 2011. Is it easy being green? On the dilemmas of material cultures of household sustainability. In: Lane, R., Gorman-Murray, A.W. (Eds.), Material Geographies of Household Sustainability. Ashgate Publishing Limited, Surrey, England, pp. 19–33.
Gifford, R., Nilsson, A., 2014. Personal and social factors that influence pro-environmental concern and behaviour: a review. Int. J. Psychol., 49(3), 141-157. Doi :https://doi.org/10.1002/ijop.12034.
Givens, J., Jorgenson, A., 2013. Individual environmental concern in the world polity: a multilevel analysis. Soc. Sci. Res. 42, 418–431. https://doi.org/10.1016/j.ssresearch.2012.10.005.
Gkargkavouzi, A., Halkos, G., Matsiori, S., 2019. How do motives and knowledge relate to intention to perform environmental behavior? Assessing the mediating role of constraints. Ecol. Econ. 165, 106394. https://doi.org/10.1016/j.ecolecon.2019.106394.
Guerra, J., Schmidt, L., Valente, S., 2016. Dilemmas of sustainability in turbulent times. In: Telesiene, A., Gross, M. (Eds.), Green European: Environmental Behaviour and Attitudes in Europe in a Historical and Cross-Cultural Comparative Perspective. Routledge, London, pp. 221–240. https://www.taylorfrancis.com/chapters/edit/10.4324/9781315648491-24/dilemmas-sustainability-turbulent-times-portuguese-case-context-jo%C3%A3o-guerra-lu%C3%ADsa-schmidt-susana-valente.
Gui, R., Meierer, M., Algesheimer, R., 2017. R Package REndo: Fitting Linear Models with Endogenous Regressors using Latent Instrumental Variables (Version 1.2). https://cran.r-project.org/web/packages/REndo/.
Hadler, M., Haller, M., 2011. Global activism and nationally driven recycling: the influence of world society and national contexts on public and private environmental behavior. Int. Sociol. 26, 315–345. https://doi.org/10.1177/0268580910392258.
Hadler, M., Haller, M., 2013. A shift from public to private environmental behavior: findings from Hadler and Haller (2011) revisited and extended. Int. Sociol. 28, 484–489. https://doi.org/10.1177/0268580913494661.
Hadler, M., Kraemer, K., 2017. The perception of environmental threats in a global and European perspective. In: Telesiene, A., Gross, M. (Eds.), Green European: Environmental Behaviour and Attitudes in Europe in a Historical and Cross-Cultural Comparative Perspective. Routledge, London, pp. 13–30. https://www.taylorfrancis.com/chapters/edit/10.4324/9781315648491-13/perception-environmental-threats-global-european-perspective-markus-hadler-klaus-kraemer.
Hair, J.F., Sarstedt, M., Ringle, C.M., Gudergan, S.P., 2018. Advanced Issues in Partial Least Squares Structural Equation Modeling. Sage Publications, Thousand Oaks, CA.
Hair, J.F., Risher, J.J., Sarstedt, M., Ringle, C.M., 2019. When to use and how to report the results of PLS-SEM. Eur. Bus. Rev. 31 (1), 2–24. https://doi.org/10.1108/EBR-11-2018-0203.
Hair, J.F., Howard, M.C., Nitzl, C., 2020. Assessing measurement model quality in PLS-SEM using confirmatory composite analysis. J. Bus. Res. 109, 101–110. https://doi.org/10.1016/j.jbusres.2019.11.069.
Hair, J.F., Hult, G.T.M., Ringle, C.M., Sarstedt, M., 2022. A Primer on Partial Least Squares Structural Equation Modeling (PLS-SEM), 3 ed. Sage, Thousand Oaks, CA.
Harring, N., 2013. Understanding the effects of corruption and political trust on willingness to make economic sacrifices for environmental protection in a cross-national perspective. Soc. Sci. Q. 94, 660–671. https://doi.org/10.1111/j.1540-6237.2012.00904.x.
Henseler, J., Ringle, C.M., Sarstedt, M., 2015. A new criterion for assessing discriminant validity in variance-based structural equation modeling. J. Acad. Mark. Sci. 43, 115–135. https://doi.org/10.1007/s11747-014-0403-8.
Hines, J.M., Hungerford, H.R., Tomera, A.N., 1987. Analysis and synthesis of research on responsible environmental behavior: a meta-analysis. J. Environ. Educ. 18, 1–8. https://doi.org/10.1080/00958964.1987.9943482.
Hobson, K., 2003. Thinking habits into action: the role of knowledge and process in questioning household consumption practices. Local Environ. 8, 95–112.
Hult, G.T.M., Hair, J.F., Proksch, D., Sarstedt, M., Pinkwart, A., Ringle, C.M., 2018. Addressing endogeneity in international marketing applications of partial least squares structural equation modeling. J. Int. Mark. 26 (3), 1–21. https://doi.org/10.1509/jim.17.0151.
IPCC, 2018. Global Warming of 1.5 °C. Special Report, October 2018. https://www.ipcc.ch/sr15/ (Date accessed: 20.04.2020).
ISSP, 2020. In: Members of the drafting group, Hadler, M., Schweighart, M., González, R., Mendez, M., Edlund, J., Franzen, A. (Eds.), Environment IV Final Source Questionnaire, May 2019. ISSP.
ISSP Research Group, 2012. ZA5500: International Social Survey Programme: Environment III - ISSP 2010. https://www.gesis.org/issp/modules/issp-modules-by-topic/environment/2010/ (Date accessed: 06.06.2019).
Keller, C., Bostrom, A., Kuttschreuter, M., Savadori, L., Spence, A., White, M., 2012. Bringing appraisal theory to environmental risk perception: a review of conceptual approaches of the past 40 years and suggestions for future research. J. Risk Res. 3, 237–256. https://doi.org/10.1080/13669877.2011.634523.
Kim, S., Choi, S.O., Wang, J., 2014. Individual perception vs. structural context: searching for multilevel determinants of social acceptance of new science and technology across 34 countries. Sci. Public Policy 41, 44–57. https://doi.org/10.1093/scipol/sct032.
Klockner, C.A., 2013. A comprehensive model of the psychology of environmental behaviour-a meta-analysis. Glob. Environ. Change-Hum. Policy Dimens. 23, 1028–1038. https://doi.org/10.1016/j.gloenvcha.2013.05.014.
Kollmuss, A., Agyeman, J., 2002. Mind the gap: why do people act environmentally and what are the barriers to pro-environmental behavior? Environ. Educ. Res. 8, 239–260. https://doi.org/10.1080/13504620220145401.
Korhonen, J., Honkasalo, A., Seppälä, J., 2018. Circular economy: the concept and its limitations. Ecol. Econ. 143, 37–46. https://doi.org/10.1016/j.ecolecon.2017.06.041.
Kotchen, M., Reiling, S., 2000. Environmental attitudes, motivations, and contingent valuation of nonuse values: a case study involving endangered species. Ecol. Econ. 32, 93–107. https://doi.org/10.1016/S0921-8009(99)00069-5.
Laroche, M., Toffoli, R., Kim, C., Muller, T.E., 1996. The influence of culture on pro-environmental knowledge, attitudes, and behavior: A Canadian perspective. In: Corfman, K.P., Lynch, J.G. (Eds.), NA - Advances in Consumer Research, vol. 23. Association for Consumer Research, Provo, UT, pp. 196–202. https://www.acrwebsite.org/volumes/7942/.
Lo, A.Y., 2014. Negative income effect on perception of long-term environmental risk. Ecol. Econ. 107, 51–58. https://doi.org/10.1016/j.ecolecon.2014.08.009.
Lo, A.Y., 2016. National income and environmental concern: observations from 35 countries. Public Underst. Sci. 25, 873–890. https://doi.org/10.1177/0963662515581302.
Lohmöller, J.B., 1989. Latent variable path modeling with partial least squares. In: Homburg, C., Klarmann, M., Vomber, A. (Eds.), Handbook of Market Research. Springer, Heidelberg.
Macias, T., 2015. Risks, trust, and sacrifice: social structural motivators for environmental change. Soc. Sci. Q. 96, 1264–1276. https://doi.org/10.1111/ssqu.12201.
Mannetti, L., Pierro, A., Livi, S., 2004. Recycling: planned and self-expressive behaviour. J. Environ. Psychol. 24, 227–236. https://doi.org/10.1016/j.jenvp.2004.01.002.
Marquart-Pyatt, S.T., 2008. Are there similar sources of environmental concern? Comparing industrialized countries. Soc. Sci. Q. 89, 1312–1335. https://doi.org/10.1111/j.1540-6237.2008.00567.x.
Marquart-Pyatt, S.T., 2012. Contextual influences on environmental concerns cross-nationally: a multilevel investigation. Soc. Sci. Res. 41, 1085–1099. https://doi.org/10.1016/j.ssresearch.2012.04.003.
Marquart-Pyatt, S.T., 2015. Public opinion about the environment: testing measurement equivalence across countries. Int. J. Sociol. 45, 309–326. https://doi.org/10.1080/00207659.2015.1098268.
Marquart-Pyatt, S.T., 2018. Trust and environmental activism across regions and countries. J. Environ. Stud. Sci. 8, 249–263. https://doi.org/10.1007/s13412-018-0498-1.
Memon, M.A., Cheah, J.-H., Ramayah, T., Ting, H., Chuah, F., 2018. Mediation analysis: issues and recommendations. J. Appl. Struct. Eq. Model. 2 (1) https://doi.org/10.47263/JASEM.2(1)01.
Menzel, S., 2013. Are emotions to blame? — the impact of non-analytical information processing on decision-making and implications for fostering sustainability. Ecol. Econ. 96, 71–78. https://doi.org/10.1016/j.ecolecon.2013.10.001.
Meyer, A., 2015. Does education increase pro-environmental behavior? Evidence from Europe. Ecol. Econ. 116, 108–121. https://doi.org/10.1016/j.ecolecon.2015.04.018.
Meyer, R., Liebe, U., 2010. Are the affluent prepared to pay for the planet? Explaining willingness to pay for public and quasi-private environmental goods in Switzerland. Popul. Environ. 32, 42–65. https://doi.org/10.1007/s11111-010-0116-y.
Minton, A.P., Rose, R.L., 1997. The effects of environmental concern on environmentally friendly consumer behavior: an exploratory study. J. Bus. Res. 40, 37–48. https://doi.org/10.1016/S0148-2963(96)00209-3.

Nauges, C., Wheeler, S., 2017. The complex relationship between households' climate change concerns and their water and energy mitigation behaviour. Ecol. Econ. 141, 87–94. https://doi.org/10.1016/j.ecolecon.2017.05.026.
Nawrotzki, R.J., 2012. The politics of environmental concern: a cross-national analysis. Organ. Environ. 25, 286–307. https://doi.org/10.1177/1086026612456535.
Nitzl, C., Roldan, J.L., Cepeda, G., 2016. Mediation analysis in partial least squares path modeling: Helping researchers discuss more sophisticated models. Ind. Manag. Data Syst. 116 (9), 1849–1864. https://doi.org/10.1108/IMDS-07-2015-0302.
Nordlund, A.M., Garvill, J., 2002. Value structures behind proenvironmental behavior. Environ. Behav. 34, 740–756. https://doi.org/10.1177/001391602237244.
O'Connor, R.E., Bard, R.J., Fisher, A., 1999. Risk perceptions, general environmental beliefs, and willingness to address climate change. Risk Anal. 19, 461–471. https://doi.org/10.1111/j.1539-6924.1999.tb00421.x.
OECD, 2014. Greening Household Behaviour: A Review for Policy Makers OECD Environment Policy Papers. OECD Publishing, Paris.
Ohler, A.M., Billger, S.M., 2014. Does environmental concern change the tragedy of the commons? Factors affecting energy saving behaviors and electricity usage. Ecol. Econ. 107, 1–12. https://doi.org/10.1016/j.ecolecon.2014.07.031.
Oreg, S., Katz-Gerro, T., 2006. Predicting proenvironmental behavior cross-nationally: values, the theory of planned behavior, and value-belief-norm theory. Environ. Behav. 38, 462–483. https://doi.org/10.1177/0013916505286012.
Otto, S., Pensini, P., 2017. Nature-based environmental education of children: environmental knowledge and connectedness to nature, together, are related to ecological behaviour. Glob. Environ. Chang. 47, 88–94. https://doi.org/10.1016/j.gloenvcha.2017.09.009.
Owens, S., 2000. 'Engaging the public': information and deliberation in environmental policy. Environ. Plan. A 32, 1141–1148. https://doi.org/10.1068/a3330.
Paço, A., Lavrador, T., 2017. Environmental knowledge and attitudes and behaviours towards energy consumption. J. Environ. Manag. 197, 384–392. https://doi.org/10.1016/j.jenvman.2017.03.100.
Pagiaslis, A., Krontalis, A.K., 2014. Green consumption behavior antecedents: environmental concern, knowledge, and beliefs. Psychol. Mark. 31, 335–348. https://doi.org/10.1002/mar.20698.
Park, S., Gupta, S., 2012. Handling endogenous Regressors by joint estimation using copulas. Mark. Sci. 31 (4), 567–586. https://doi.org/10.1287/mksc.1120.0718.
Peattie, K., 2010. Green consumption: behavior and norms. Annu. Rev. Environ. Resour. 35, 195–228. https://doi.org/10.1146/annurev-environ-032609-094328.
Poortinga, W., Steg, L., Vlek, C., 2004. Values, environmental concern, and environmental behavior - a study into household energy use. Environ. Behav. 36, 70–93. https://doi.org/10.1177/0013916503251466.
Rees, W.E., 2020. Ecological economics for humanity's plague phase. Ecol. Econ. 169, 106519. https://doi.org/10.1016/j.ecolecon.2019.106519.
Richter, N.F., Cepeda-Carrión, G., Roldán Salgueiro, J.L., Ringle, C.M., 2016. European management research using partial least squares structural equation modeling (PLS-SEM). Eur. Manag. J. 34 (6), 589–597. https://doi.org/10.1016/j.emj.2016.08.001.
Ringle, C., Sarstedt, M., 2016. Gain more insight from your PLS-SEM results the importance-performance map analysis. Ind. Manag. Data Syst. 116, 1865–1886. https://doi.org/10.1108/IMDS-10-2015-0449.
Ringle, C.M., Wende, S., Becker, J.M., 2015. SmartPLS 3. http://www.smartpls.com.
Roberts, J.A., Bacon, D.R., 1997. Exploring the subtle relationships between environmental concern and ecologically conscious consumer behavior. J. Bus. Res. 40, 79–89. https://doi.org/10.1016/S0148-2963(96)00280-9.
Roldán, J.L., Sánchez-Franco, M.J., 2012. Variance-based structural equation modeling: Guidelines for using partial least squares in information systems research. In: Mora, M., Gelman, O., Steenkamp, A.L., Raisinghani, M. (Eds.), Research Methodologies, Innovations and Philosophies in Software Systems Engineering and Information Systems. IGI Global, Hershey, PA, pp. 193–221. https://www.igi-global.com/chapter/content/63264.
Sachs, J., Schmidt-Traub, G., Kroll, C., Lafortune, G., Fuller, G., Woelm, F., 2020. The sustainable development goals and COVID-19. In: Sustainable Development Report 2020. Cambridge University Press, Cambridge.
Sapci, O., Considine, T., 2014. The link between environmental attitudes and energy consumption behavior. J. Behav. Exp. Econ. 52, 29–34. https://doi.org/10.1016/j.socec.2014.06.001.
Sarstedt, M., Hair, J.F., Ringle, C.M., Thiele, K.O., Gudergan, S.P., 2016. Estimation issues with PLS and CBSEM: where the bias lies! J. Bus. Res. 69, 3998–4010. https://doi.org/10.1016/j.jbusres.2016.06.007.
Sarstedt, M., Ringle, C.M., Hair, J.F., 2017. Partial least squares structural equation modeling. In: Homburg, C., Klarman, M., Vomberg, A. (Eds.), Handbook of Market Research. Springer, Heidelberg, pp. 1–40. https://www.researchgate.net/profile/Stephen-Parry/post/How-to-determine-the-sample-size-for-PLS-SEM/attachment/5ee0fd5bcf1f7a00018db2dc/AS%3A900902181425153%401591803226941/download/2017_Sarstedtetal._HandbookofMarketResearch.pdf.
Schafer, J.L., Olsen, M.K., 1998. Multiple imputation for multivariate missing-data problems: a data analyst's perspective. Multivar. Behav. Res. 33, 545–571. https://doi.org/10.1207/s15327906mbr3304_5.
Schaffrin, A., Schmidt-Catran, A., 2017. Changing concern about environmental threats and risks: A longitudinal and multilevel perspective on the relationship between values and interests. In: Telesiene, A., Gross, M. (Eds.), Green European: Environmental Behaviour and Attitudes in Europe in a Historical and Cross-Cultural Comparative Perspective. Routledge, London, pp. 56–88. https://lirias.kuleuven.be/2946688?limo=0.
Shmueli, G., Sarstedt, M., Hair, J.F., Cheah, J.H., Ting, H., Vaithilingam, S., Ringle, C.M., 2019. Predictive model assessment in PLS-SEM: guidelines for using PLSpredict. Eur. J. Mark. 53, 2322–2347. https://doi.org/10.1108/ejm-02-2019-0189.
Spaargaren, G., Oosterveer, P., 2010. Citizen-consumers as agents of change in globalizing modernity: the case of sustainable consumption. Sustainability 2, 1887–1908. https://doi.org/10.3390/su2071887.
Steg, L., Vlek, C., 2009. Encouraging pro-environmental behaviour: an integrative review and research agenda. J. Environ. Psychol. 29, 309–317. https://doi.org/10.1016/j.jenvp.2008.10.004.
Stern, P.C., 2000. New environmental theories: toward a coherent theory of environmentally significant behavior. J. Soc. Issues 56, 407–424. https://doi.org/10.1111/0022-4537.00175.
Stern, P.C., Dietz, T., Abel, T., Guagnano, G.A., Kalof, L., 1999. A value-belief-norm theory of support for social movements: the case of environmentalism. Hum. Ecol. Rev. 81–97. https://www.jstor.org/stable/24707060.
Straughan, R.D., Roberts, J.A., 1999. Environmental segmentation alternatives: a look at green consumer behavior in the new millennium. J. Consum. Mark. 16, 558–575. https://doi.org/10.1108/07363769910297506.
Tam, K.P., Chan, H.W., 2018. Generalized trust narrows the gap between environmental concern and pro-environmental behavior: multilevel evidence. Glob. Environ. Chang. 48, 182–194. https://doi.org/10.1016/j.gloenvcha.2017.12.001.
Tikka, P.M., Kuitunen, M.T., Tynys, S.M., 2000. Effects of educational background on students' attitudes, activity levels, and knowledge concerning the environment. J. Environ. Educ. 31 (3), 12–19. https://doi.org/10.1080/00958960009598640.
Truelove, H.B., Gillis, A.J., 2018. Perception of pro-environmental behavior. Glob. Environ. Chang. 49, 175–185. https://doi.org/10.1016/j.gloenvcha.2018.02.009.
Turaga, R., Howarth, R., Borsuk, M., 2010. Pro-environmental behavior: rational choice meets moral motivation. Ann. N. Y. Acad. Sci. 1185, 211–224. https://doi.org/10.1111/j.1749-6632.2009.05163.x.
Urban, D., Hoban, T.J., 1997. Cognitive determinants of risk perceptions associated with biotechnology. Scientometrics 40 (2), 299–331. https://doi.org/10.1007/BF02457441.
Vainio, A., Paloniemi, R., 2014. The complex role of attitudes toward science in pro-environmental consumption in the Nordic countries. Ecol. Econ. 108, 18–27. https://doi.org/10.1016/j.ecolecon.2014.09.026.
Van Liere, K., Dunlap, R., 1981. Environmental concern: does it make a difference how it's measured? Environ. Behav. 13, 651–676. https://doi.org/10.1177/0013916581136001.
Vermeir, I., Verbeke, W., 2006. Sustainable food consumption: exploring the consumer "attitude–behavioral intention" gap. J. Agric. Environ. Ethics 19, 169–194. https://doi.org/10.1007/s10806-005-5485-3.
Vermeir, I., Verbeke, W., 2008. Sustainable food consumption among young adults in Belgium: theory of planned behaviour and the role of confidence and values. Ecol. Econ. 64, 542–553. https://doi.org/10.1016/j.ecolecon.2007.03.007.
Wachinger, G., Renn, O., Begg, C., Kuhlicke, C., 2012. The risk perception paradox - implications for governance and communication of natural hazards. Risk Anal. 33 (6), 1049–1065. https://doi.org/10.1111/j.1539-6924.2012.01942.x.
Wackernagel, M., Schulz, N., Deumling, D., Linares, A., Jenkins, M., Kapos, V., Monfreda, C., Loh, J., Myers, N., Norgaard, R., Randers, J., 2002. Tracking the ecological overshoot of the human economy. Proc. Natl. Acad. Sci. U. S. A. 99, 9266–9271. https://doi.org/10.1073/pnas.142033699.
Wakefield, S., Elliott, S., Eyles, J., Cole, D., 2006. Taking environmental action: the role of local composition, context, and collective. Environ. Manag. 37, 40–53. https://doi.org/10.1007/s00267-004-0323-3.
Wang, Y., 2017. Promoting sustainable consumption behaviors: the impacts of environmental attitudes and governance in a cross-national context. Environ. Behav. 49, 1128–1155. https://doi.org/10.1177/0013916516680264.
Wilsdon, J., Wynne, B., Stilgoe, J., 2005. The Public Value of Science. Demos, London. http://zgora.pte.pl/pliki/2/21/5.%20Vinnova%20Public%20Value%20of%20Science%202005.pdf.
Wold, H.O.A., 1982. Soft modeling: The basic design and some extensions. In: Jöreskog, K.G., Wold, H.O.A. (Eds.), Systems under Indirect Observations: Part II. North-Holland, Amsterdam, pp. 1–54.
Wynne, B., 1992. Misunderstood misunderstanding: social identities and public uptake of science. Public Underst. Sci. 1, 281–304. https://doi.org/10.1088/0963-6625/1/3/004.
Xiao, C., Dunlap, R.E., 2007. Validating a comprehensive model of environmental concern cross-nationally: a U.S.-Canadian comparison. Soc. Sci. Q. 88, 471–493. https://doi.org/10.1111/j.1540-6237.2007.00467.x.
Yadav, R., Pathak, G.S., 2017. Determinants of consumers' green purchase behavior in a developing nation: applying and extending the theory of planned behavior. Ecol. Econ. 134, 114–122. https://doi.org/10.1016/j.ecolecon.2016.12.019.
Zsóka, Á., Szerényi, Z.M., Széchy, A., Kocsis, T., 2013. Greening due to environmental education? Environmental knowledge, attitudes, consumer behavior and everyday pro-environmental activities of Hungarian high school and university students. J. Clean. Prod. 48, 126–138. https://doi.org/10.1016/j.jclepro.2012.11.030.