Received: 29 June 2022 | Revised: 24 November 2022 | Accepted: 5 December 2022

DOI: 10.1002/bse.3338

RESEARCH ARTICLE

Business Strategy and the Environment

WILEY

Sustainable development and greenwashing: How blockchain technology information can empower green consumers

Arne Nygaard[1,2] | Ragnhild Silkoset[3,4]

[1]Postboks 1155 Sentrum, Kristiania University College, Oslo, Norway

[2]Department of Tourism & Northern Studies, UiT The Artic University of Norway, Alta, Norway

[3]Department of Marketing, BI Norwegian Business School, Oslo, Norway

[4]School of Business and Economics, UiT The Artic University of Norway, Tromso, Norway

Correspondence
Arne Nygaard, Kristiania University College, Postboks 1155 Sentrum, 0107 Oslo, Norway.
Email: arne.nygaard@kristiania.no

Abstract

The unethical behavior of greenwashing threatens the growth of sustainable products and markets. Greenwashing degrades essential efforts to reduce climate change and pollution and to promote social justice. False marketing communication that claims products are sustainable hurts the value of green products and weakens customer capability to prefer sustainable to nonsustainable products. Greenwashing also eliminates trust in "green" products. Markets infected by fake "green" products ultimately fail to provide the necessary sustainable transformation. Our study demonstrates that consumer access to reliable transparent, traceable, and tamperproof product information counteracts perceived greenwashing among consumers of ecological foods. Furthermore, our data indicate that blockchain information significantly more than certification systems safeguard consumers against the threat of greenwashing. Information validating authenticity promotes the development of sustainable products, protects intellectual property rights for suppliers of green products, and safeguards the supply of green products to consumers. Consumers need key information that ensures the provenance of green products. Conventional wisdom endorses certifications to constrain greenwashing. However, we find that blockchain information dimensions protect brands against perceived greenwashing more robustly than certification systems.

KEYWORDS
green certification, greenwashing, tamperproof information, traceability, transparency

1 | INTRODUCTION

Perceived greenwashing is a threat to the trust in products, brands, companies, institutions, and our sustainable future in general. The former US Vice President, environmental activist, and Nobel Laureate Al Gore presented greenwashing as "confusing and often misleading claims about sustainability benefits" that "is 'rising threat' that could derail climate progress" (Sky News, 2021). Greenwashing is the unethical behavior of "misleading customers about their environmental performance or benefits of a product or service" (Delmas & Burbano, 2011). Greenwashing, however, is often mistakenly defined as an intention and not caused by bounded rationality like "honest mistakes," a lack of information, or other behavior not related to harmful objectives (Seele & Gatti, 2017).

The current competitive race to develop new "green" products and markets incentivizes unethical decisions to falsely present

Abbreviations: NGO, nongovernmental organization; ISO, International Organization for Standardization; TS, technical specification; RFID, radio-frequency identification; QR, quick response.

products as "sustainable." The growing market segment of consumers focused on sustainability in many countries is an attractive force behind greenwashing. For instance, a recent McKinsey and Company (2020) report explained that 66% of respondents and a staggering 75% of the millennial respondents reported that their purchase decisions were based on the perceived level of sustainability of a product. In the growing market for green products, Millennials represent consumers who have capabilities to support their consumer behavior with information from social media or other digital sources. The companies that produce "green" products have expanded their business to supply the growing sustainable consumer markets. So, the same companies see great opportunities by transforming their business according to environmental, social, and governance factors.

Not surprisingly, companies have strong incentives to change their image to greener communication of nonsustainable operations (Callery & Perkins, 2021). The European Commission and national consumer authorities publish each year a screening research report of websites (EU, 2021). Here, they analyze the number of breaches of EU consumer law in online markets. The research in 2021 investigated the level of greenwashing where companies present their business as green when it is not. In more than 50% of all cases, their green communication was inaccurate and wrong. In 37% of cases, companies presented their products as "conscious," "eco-friendly," and "sustainable" when such claims were undocumented speculations (EU, 2021). Unfair commercial, deceptive, and false greenwashing practice was found in 42% of cases (EU, 2021).

According to the Economist (2021), an analysis of the 20 biggest environmental, social, and governance funds revealed a shocking number of greenwashed companies. The Economist (2021) found that each of the "green" funds invested in 17 fossil-fuel producers like Exxon Mobil and Saudi Aramco, Chinese coal mining, gambling, booze, and tobacco companies. The International Consumer Protection Enforcement Network found that nearly half of eco-friendly product claims could be breaking laws because of unvalidated and false market communication (Shankleman, 2021). Examples include baby wipes that claim to be 0% plastic and dairy-free milk announced as "sustainably sourced."

One of the central problems is eco-labels and green certifications that are not supported by valid information sources or institutions capable of enforcing and controlling restrictions. In a complex world of global supply chains, it is difficult and costly to control and enforce standards and restrictions defined by green certifications and eco-labels. For instance, both Coen et al. (2022) and Heras-Saizarbitoria et al. (2020) found weak environmental performance following green certification. Often, unethical market communication hides valid information about sustainability. Well-off middle-class consumers with high preferences for "green" products are looking for information to navigate and protect their green consumption (Natural Marketing Institute, 2021). Consequently, they also have the capacity to pay price premiums for sustainable products. The market attractiveness of well-off green consumers produces motives to greenwash products and communication. Greenwashing by presenting nonexistent or poor sustainability as "green" is a new profitable marketing strategy of "eco-opportunism" (Nygaard, 2022). It is self-interest-seeking unethical behavior with guile to mislead "green" consumers attracted to sustainable products. The motive is to achieve access to profitable segments and price premiums for green products. The downside risk of this unethical behavior is the destroying of "green" markets when consumers cannot confirm the true capacity to separate "green" products from other products. The ultimate outcome of perceived greenwashing over time is the elimination of confidence in the markets for "green" products. The companies that greenwash market communication also risk boycott actions if they get caught (Friedman, 1985). The Natural Marketing Institute, which monitors potential counteractive actions among consumers and consumer segments, reports that 40% (up 21% since 2015) and 58% of the Millennials segment of American consumers have stopped buying a product after learning that the company/brand did not practice environmental responsibility (Natural Marketing Institute, 2022, Consumer Trends Report). Earlier studies, though, indicated that although many consumers supported the boycott motives, few were likely to boycott because of cost–benefit evaluations (Klein et al., 2004). The word-of-mouth impact (Arndt, 1968) of unethical behavior in social media probably has a stronger defecting effect on the willingness to buy in the current market than before. Furthermore, the cost of buying fake consumer products like ecological food is probably perceived as being greater than more distant issues not characterized by strong personalized self-interests and costs.

2 | EMPIRICAL RESEARCH ON GREENWASHING

Greenwashing has become an important avenue for empirical research since 2005. Table 1 exhibits the most cited empirical articles (Google Scholar citations >100) on greenwashing. The area reflects diverse international interests in the subject. Empirical research has been published based on data from China (Xingqiang, 2015; Zhang et al., 2018), Germany (Schmuck et al., 2018), France (Parguel et al., 2011, 2015), the United States (Berrone et al., 2017; Mahoney et al., 2013; Nyilasy et al., 2014; Rahman et al., 2015; Siano et al., 2017), the United Kingdom (Smith & Font, 2014), and the Netherlands (De Vries et al., 2015). Marquis et al. (2016) and Ramus and Montiel (2005) have gathered data from many countries. The area of high-impact research on greenwashing also represents a variation of industries and cross-sectional, longitudinal quantitative methods (Marquis et al., 2016) and content analysis (Siano et al., 2017; Smith & Font, 2014) (Table 1). The status of greenwashing research presents a broad relevance across countries and industries.

The research productivity and high impact of research in the area reflect the growing importance of problems associated with the sustainable transformation of markets and consumption. Most empirical research has focused on how stakeholders (Mahoney et al., 2013), like customers (Nyilasy et al., 2014), employees (Ramus & Montiel, 2005), and investors (Xingqiang, 2015), respond to the threat of greenwashing. Studies on greenwashing report various outcome effects. Except

TABLE 1 The most cited (Google Scholar citations >100) published empirical analyses of greenwashing after 2005

Article	Journal	Data	Methods	Contribution
Xingqiang, D. (2015)	Journal of Business Ethics 128(3), 547–574	561 observations based on the newspaper south weekend and China stock market and accounting research	Multivariate tests	Greenwashing is significantly negatively related to performance in a firm and positively related to performance among their competitors.
Smith V. L. & Font, X. (2014)	Journal of Sustainable Tourism 22(6), 942–963	Nonrandom sample of UK websites presenting eight organizations	Content analysis of websites	Volunteer tourism operators' communication of responsibility indicates greenwashing and an inverse relationship between price and responsibility communication.
Zhang, L., Li, D., Cao, C., & Huang, S. (2018)	Journal of Cleaner Production 187, 740–750	Questionnaire survey of 553 battery consumers in China	Structural equation modeling (SEM)	Greenwashing is negatively associated with green purchasing intentions.
Schmuck, D., Matthes, J., & Naderer, B. (2018)	Journal of Advertising 47(2), 127–145	Quota-based samples from US ($N = 486$) and Germany ($N = 300$)	Confirmatory factor analysis and maximum likelihood estimation	False claims increased perceived greenwashing. Greenwashing decreased attitudes toward ads and brands.
De Vries, G., Terwel, B. W., Ellemers, N., & Daamen, D. D. (2015)	Corporate Social Responsibility and Environmental Management 22(3), 142–154	79 Dutch undergraduate students	Analysis of variance (ANOVA)	People suspect greenwashing when energy companies communicate environmental motives rather than economic motives. Also, respondents suspected strategic behavior when the company communicated profit-motivated behavior rather than environment-motivated behavior.
Nyilasy, G., Gangadharbatla, H., & Paladino, A. (2014)	Journal of Business Ethics 125(4), 693–707	302 students in the USA	Analysis of variance (ANOVA)	Negative effects of a firm's low performance on brand attitudes become stronger because of green advertising. But when environmental performance is high, green advertising leads to more unfavorable brand attitudes.
Berrone, P., Fosfuri, A., & Gelabert, L. (2017)	Journal of Business Ethics 144(2), 363–379	Longitudinal data from 1997 and 2001 from 325 US firms in polluting industries	Ordinary least squares (OLS)	Results indicate that companies that keep their promises gain environmental legitimacy and that greenwashing can backfire.
Siano, A., Vollero, A., Conte, F., & Amabile, S. (2017)	Journal of Business Research 71, 27–37	Three sustainability reports of the VW group, interviews with former VW managers, and headlines of the top 25 US daily newspapers	Content analysis	The study identified "deceptive manipulation" as a new form of greenwashing.
Parguel, B., Benoit-Moreau, F., & Russell, C. A. (2015)	International Journal of Advertising 34(1), 107–134	110 respondents from a professional market research firm in France	Analysis of variance (ANOVA)	Greenwashed web pages generate greater perceptions of the ecological image of the brand.
Mahoney, L. S., Thorne, L., Cecil, L., & LaGore, W. (2013)	Critical Perspectives on Accounting 24(4–5), 350–359	312 US firms that issue CSR reports and similar firms without CSR reports	Logistic regression	Firms that voluntarily issue standalone CSR reports have higher CSR performance than firms that do not issue these reports. Firms that follow GRI standards have higher CSR than firms that do not follow GRI standards.
Rahman, I., Park, J., & Chi, C. G. Q. (2015)	International Journal of Contemporary Hospitality Management 27(6), 1054–1081	638 staff members of a US public university	Analysis of variance (ANOVA)	Motive of hotels' environmental claims evoked skepticism and constrained the intention to revisit.

(Continues)

TABLE 1 (Continued)

Article	Journal	Data	Methods	Contribution
Marquis, C., Toffel, M. W., & Zhou, Y. (2016)	Organization Science 27(2), 483–504	Panel set of 4750 public companies across industries in 45 countries between 2004 and 2007	Multilevel mixed-effects linear regression	Firms that are more environmentally damaging are less likely to engage in selective disclosure like benign impacts, creating an impression of transparency and masking true environmental performance.
Parguel, B., Benoît-Moreau, F., & Larceneux, F. (2011)	Journal of Business Ethics 102(1), 15–28	122 French professionals from a panel of a research institute	Analysis of variance (ANOVA)	Results indicate a negative effect of a poor sustainability rating. Sustainability ratings deter greenwashing.
Ramus, C. A., & Montiel, I. (2005)	Business & Society 44(4), 377–414	236 corporate environmental policies from 1993 to 1998 and survey among 586 employees in 10 leading European firms	Logistic regression	The study shows that companies accept committing to environmental policies but low rates of adoption of specific environmental policies.

for Parguel et al. (2015), other studies report that greenwashing decreases the value or competitiveness of a firm (Xingqiang, 2015), decreases the value of ads or brands (Schmuck et al., 2018), or terminates the consumer choice of green products when they suspect greenwashing (Rahman et al., 2015). The presented review of previous high-impact research identifies greenwashing as a problem (Siano et al., 2017). It shows the negative outcome effects of greenwashing (Parguel et al., 2011). Nevertheless, when we look at the high-impact papers in this area, there is a lot of interest in the negative outcomes of greenwashing. Yet, there are many under-researched areas of how businesses can avoid and control greenwashing. Furthermore, we know little about the way information and certifications protect consumers' choice of green products against perceived greenwashing.

3 | THEORETICAL PERSPECTIVES AND RESEARCH MODEL

Available information and certification systems can protect consumers against perceived greenwashing. In this paper, we analyze these two counteracting strategies. Consumers feel that one or another is more effective at safeguarding them against perceived greenwashing in the context of ecological food. Ecological food is associated with both health and sustainability issues.

A global web index study (Arya, 2019) indicated that over 60% of Millennials want to pay more for ecological products. Given the context of information asymmetry in the supply chain from "farm to fork," there is a systemic incentive to cheat consumers when monitoring is costly and there is a lack of legal enforcement systems.

Recently, there has been a development in the technology of producing tamperproof, transparent, and traceable information applicable to consumer choice and evaluation. Blockchain technology has provided protection for consumer markets. For instance, Aura Blockchain makes it possible for consumers to track the history of the product and proof of authenticity of luxury goods like Prada and Cartier, from production to sales. The same technology follows Walmart's vegetables from "farm to fork" and makes it possible to trace a product back to the farm in just 2.2 seconds. Thus, transparent, traceable, and tamperproof information makes consumers trust the markets and the products. Another case is the company Provenance that has developed contracts through blockchain technology to empower and facilitate sustainable consumer choices in the food market. Their technology can control whether slave labor has produced the tuna fish sold in British supermarkets. According to the Global Slavery Index (2018), "two thirds of the estimated 45.8 million people in modern slavery were identified in the Asia-Pacific" (https://www.globalslaveryindex.org/2018/findings/regional-analysis/asia-and-the-pacific/). Furthermore, some species of tuna fish are red listed. Thus, there is a potential for the extinction of some species of tuna fish. Consequently, both social responsibility and environmental aspects call for transparency in the supply chain. Transparency is the "ability to identify and trace the history, distribution, location, and application of products, parts, and materials, to ensure the reliability of

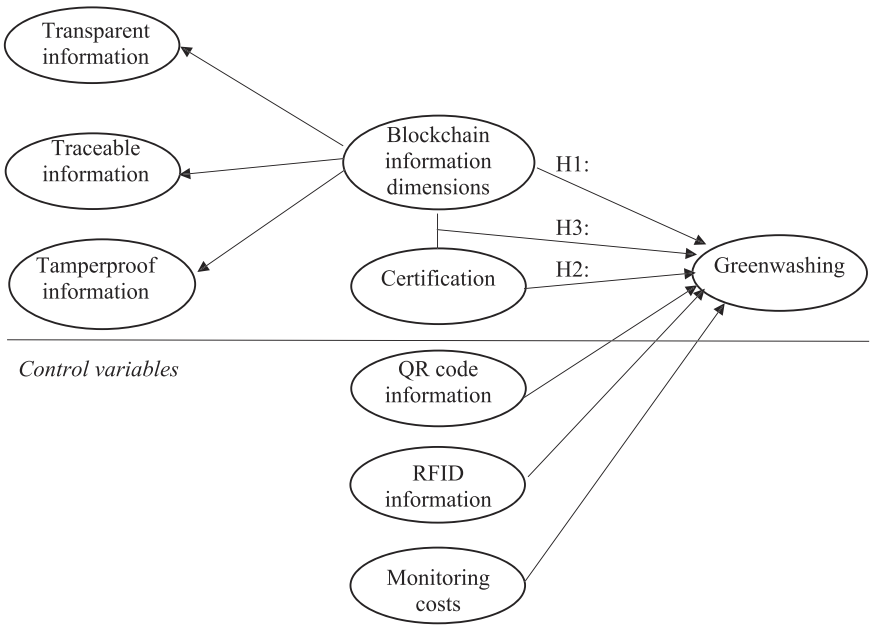

FIGURE 1 Research model investigating factors affecting greenwashing

sustainability claims, in the areas of human rights, labor (including health and safety), the environment, and anti-corruption" (United Nations, 2014). Consumer access to information is therefore crucial to the green transition of markets (Rahman & Nguyen-Viet, 2022). Transparency of information shared with NGOs, state authorities, or unions provide control systems that safeguard consumer interests in local and global markets (Gupta, 2008). We investigate how different sources of information and certification have the capacity to curb potential perceived greenwashing. Figure 1 below presents the conceptual model.

3.1 | Information to protect green consumers

Some markets develop dysfunctionalities described as "lemon" markets (Akerlof, 1970). The empirical reference is street markets for rice in India, where information asymmetry between sellers and buyers ultimately leads to a situation where markets disintegrate because fake rice outcompetes authentic rice. Markets for "green" ecological food are characterized by similar problems. Complex supply chains and production technologies might reduce consumers' capability to make rational and informed decisions. It creates information asymmetry between the consumers who are unable to monitor the true capacity of the "green" products.

The environment of asymmetric information between consumers and complex supply chains facilitates unethical opportunistic behavior like greenwashing (Williamson, 1973). Therefore, the context of information asymmetry may incentivize unethical behavior. Determining the true quality due to information asymmetry in the market is a complex consumer problem. Technology makes it possible to transfer data that can mitigate and constrain the information asymmetry between "green" consumers and the product life cycle through the supply chains. The application of blockchain technology can produce tamperproof, transparent, and traceable information from "farm to fork." The consumers of ecological food can therefore trust the product based on the validity of the information. In this study, we want to investigate the need for these dimensions of information sources to control the perceived greenwashing of ecological food products. The lemons problem of presenting nonecological food as ecological (green) is a parallel to where Akerlof (1970) illustrates the case of mixing rice and white stones to cheat buyers. Current theory suggests that customer access to transparent, traceable, and tamperproof data may support traditional counteracting institutions like guarantees, brands, and certifications (North, 1990). Consumers need access to reliable product information verifying that "green" food really is "green" (Kim & Laskowski, 2017). The technology has the capacity to provide traceable, tamperproof, and transparent information about the sustainable performance of the product.

> **H1.** The more the consumer trusts the traceable, transparent, and tamperproof information, the less they perceive greenwashing.

3.2 | Certifications to protect green consumers

Certifications are known as counteracting institutions that protect products against greenwashing. Thus, the use of green certifications is intended and planned counteracting institutions to control lemon markets, that is, to ensure that false green products do not enter the market. Certifications enforce standards that are "green" or "sustainable." For example, there are several "green" certifications in the food

industry. Certification of a product provides a best practice of "green" standardized quality that signals the sustainable performance expected by the consumers of ecological food. The EU established, for instance, the Eco-Label system in 1992 to provide a market alternative to consumers who prefer products that do not harm health or the environment.

The EU certification standards are as follows:

- TS ISO 14020 Ecological labels and statements—General principles
- TS ISO 14024 Ecological labels and declarations—Type 1: Environmental labeling—Principles and methods
- TS ISO 14021 Ecological labels and declarations—Type 2: Environmental labels—Self-declaration of environmental claims
- TS ISO 14025 Ecological labels and declarations—Type 3: Environmental declarations—Principles and procedures.

Following these certifications permits a company to use the Ecomark tag to produce an advantage for "green" products. These EU certifications of ecological products are in fact contracts connecting consumers and suppliers regulated by institutionalized trust (Zucker, 1986). As we see from, for instance, US history, the legal system and trade laws protected contracts and market transactions. Trade laws and certifications expanded after the Civil War (Hurst, 1956) and supported the disruptive evolution of the modern business enterprise (Chandler, 1962, 1990). The bases for institutionalized trust are "tied to broad societal institutions, depending on individual or firm-specific attributes (e.g., certification)" (Zucker, 1986, p. 60). The transformation of planning economies into new market economies indicates that institutionalized trust like certifications was a paramount factor during the development from communism to market capitalism (Dahlstrom & Nygaard, 1995). Likewise, the growth of markets for "green" ecological products depends on the institutional trust in the EU certification system.

Structures that safeguard transactions like certification promises, legal recourse, processes, and procedures supported the business evolution (McKnight & Chevarny, 2001-2002, p. 48). Certifications rest on the institutional trust in the system (Giddens, 1990; Luhmann, 2014). The system, where lawyers, banks, accountants, and others certify governance mechanisms, safeguards business transactions. Economic growth of ecological products "reflect[s] the need for institutional production of trust" (Zucker, 1986).

> **H2.** The greater the knowledge about certification schemes for ecological vegetables, the less the perceived greenwashing.

3.3 | Information versus certification

While access to trusted transparent, traceable, and tamperproof product information empowers consumers to identify greenwashing, certification is based on laws, regulations, and enforcement to guarantee product quality. Empowering consumers with the ability to make the right decision has a stronger negative effect on perceived greenwashing than the negative effect of certification on perceived greenwashing.

> **H3.** The effect of consumer trust in traceable, transparent, and tamperproof information on perceived greenwashing is stronger than the effect of certification schemes for ecological vegetables on perceived greenwashing.

3.4 | Control variables

To control for other variables that might affect the market for ecological food, we applied how much the consumers (respondents) know about RFID and QR technology, in addition to the time and effort they use to monitor the product prior to purchase (monitoring costs). Finally, the study included a sales channel to control for the nature of the sector/product. The sales channel compares farmers' markets with retail stores.

4 | RESEARCH METHODOLOGY

4.1 | Operationalization

Perceived greenwashing is measured through consumers' perception of misleading information regarding the true quality of ecological vegetables (Szabo & Webster, 2021). We measure perceived greenwashing with four items by asking the respondents about the difficulty of knowing whether the ecological vegetables are what they claim to be. The measures are adapted from the performance ambiguity construct by Heide and Miner (1992). All items in the study are reported in Table 1, and all latent constructs used a Likert scale (1 = *strongly disagree*, 2 = *disagree*, 3 = *neither/nor*, 4 = *agree*, 5 = *strongly agree*). Cronbach's alpha of the perceived greenwashing construct is .864. All questions used in the research model are reported in Table A1 in Appendix A.

The blockchain information dimensions are defined as a higher order construct built from three information dimensions generated from the blockchain literature (Iansiti & Lakhani, 2017). These were transparent information, traceable information, and tamperproof information. Transparent information is adapted from Yiannas's (2018) concept and measured with three items on a Likert scale, asking whether the respondent was confident that he/she got access to all relevant information for his/her purchase. Cronbach's alpha is .910. Traceable information is measured with five items, asking about the trust in the traceability of the vegetable information regarding nutrition, product methods, and origin (Van Rijswijk & Frewer, 2008). Cronbach's alpha was .775. Tamperproof information is measured with four items, asking about the degree of trust in whether the information on the vegetables had never been manipulated or tampered with. Cronbach's alpha is .960. The higher order blockchain information dimension has a Cronbach alpha of .820.

Certification is measured with one item, asking the respondents about the degree to which they are familiar with certification schemes for ecological vegetables. On average, the respondents reported having a high level of knowledge on this matter, with a mean value of 2.96 (*SD* 1.330). This indicates that green consumers in the health and sustainability segment are often well informed in this area.

Information technology measures the degree to which a respondent is familiar with information obtained by QR codes and radio frequency identification (RFID). The respondents reported higher knowledge with QR codes (mean value 2.270, *SD* 1.156) than with RFID information (mean value 1.780, *SD* 1.054). Monitoring costs measures the time and resources a respondent uses to ensure that the vegetables are ecological. Four items measure the perceived effort in using time to ensure the authenticity of the ecological vegetables. Cronbach's alpha is .982. Finally, the control variable of practice measures the average percentages of ecological vegetables that the respondents buy.

4.2 | Sampling

The sample consists of 492 respondents. Among these, 289 respondents are from a vegetarian Facebook interest group, while 303 respondents are Facebook members outside this group.

One respondent was deleted due to a high Mardia-based Kappa kurtosis score. There was a large overweighting of female respondents (82.9%) compared to male respondents (14.9%) and those who did not want to report their gender (2.2%). The civil status corresponds to the national numbers, with 25.1% married, 30% cohabiting, and the rest being single or having a boy/girlfriend. We asked about the highest academic degree. The respondents reported that 2.9% had completed elementary school, 32.1% high school, 32.8% a bachelor's degree, 25.7% a master's degree, and 1.1% a PhD degree. On average, 89.2% of the respondents bought vegetables at the local store, 7.5% at farmers' markets, and 2.6% by online shopping. Moreover, 31.7% of the respondents bought vegetables that were marked as ecological. Few respondents reported knowledge about the blockchain technology, with a mean value of 1.79 (*SD* 1.046) on a scale from 1 to 5. The initial analysis did not replace missing variables, which means that the results were based on 428 cases.

The inclusion of two sampling groups, where one is represented by a special interest in ecological vegetables, facilitates the external validity of the study. This is because the variation of involvement among these groups captures data variation (Sallis et al., 2021).

4.3 | Validity

To test the validity of the research model, we began with a confirmatory factor analysis utilizing the structural equation modeling technique. The measurement model, reported in Table 2, shows that all items have a factor loading of .4 or higher.

TABLE 2 Confirmatory measurement model

Construct	SE	Factor loading	*z* score
Greenwashing			
Item 1	-	.514	1.000[a]
Item 2	.097	.861	11.134
Item 3	.088	.929	11.376
Item 4	.087	.795	10.762
Transparent information			
Item 1	-	.823	1.000[a]
Item 2	.046	.971	24.389
Item 3	.047	.823	20.938
Traceable information			
Item 1	-	.671	1.000[a]
Item 2	.090	.445	7.692
Item 3	.077	.660	10.599
Item 4	.077	.647	10.457
Tamperproof information			
Item 1	-	.872	1.000[a]
Item 2	.036	.916	28.336
Item 3	.033	.961	31.804
Item 4	.033	.952	31.128
Blockchain information dimensions			
Transparent information	.050	.661	11.435
Traceable information	.053	.893	11.477
Tamperproof information	.056	.654	11.868
Certification			
Item 1	-	1.00	1.000[b]
QR code information			
Item 1			
RFID information	-	1.00	1.000[b]
Item 1	-	1.00	1.000[b]
Monitoring costs			
Item 1	-	.927	1.000[a]
Item 2	.024	.963	41.596
Item 3	.022	.986	46.583
Item 4	.022	.988	47.167
Practice			
Item 1	-	1.00	1.000[b]
Sales channel			
Item 1	-	1.00	1.000[b]

[a]Standardized factor loading,
[b]Single-item construct. Based on maximum-likelihood estimation.

Table 3 reports descriptive statistics together with correlation coefficients and the constructs' average variance extracted. Discriminant validity was tested by running a series of models where two pairs of constructs were fixed to 1.000. All numbers turned out to be statistically significant. As an example, the chi-square between perceived greenwashing and blockchain was 254.843 (1 DF) (*p* value <.01).

TABLE 3 Descriptive statistics with correlation matrix

	Variable	Mean	SD	1	2	3	4	5	6	7	8
1	Greenwashing	2.849	1.090	.625							
2	Blockchain information dimensions	3.500	.742	−.420**	.586						
3	Certification	2.960	1.330	−.285**	.168**	--[a]					
4	QR code information	2.270	1.156	−.168**	.083	.500**	--[a]				
5	RFID information	1.780	1.054	−.112*	.093	.325**	.585**	--[a]			
6	Monitoring costs	3.607	1.294	−.241**	.085	.091	.052	−.063	.931		
7	Practice	31.660	27.202	−.109*	.034	.097*	.024	.046	.414**	--[a]	
8	Sales channel	7.50	15.085	−.105*	.021	.165**	.108*	.129**	.159**	.261**	--[a]

[a]Single-item construct.
**p value <.01,*p value <.05.

TABLE 4 Results from the structural equation modeling

	Dependent variable Greenwashing			
Independent variables	**Beta coefficient**	**SE**	**Standardized beta**	**z score**
H1: Blockchain information dimensions	−.264	.042	−.402	−6.297**
H2: Certification	−.085	.027	−.173	−3.131**
H3: Blockchain information dimension > certification	.177			10.619[a].**
Control variables				
QR codes information	−.033	.035	−.058	−.950
RFID information	.016	.035	.026	.467
Monitoring costs	−.084	.028	−.160	−3.054**
Practice	−.000	001	−.018	−.359
Sales channel	.002	.002	−.042	−.895
R^2	28.4%			

[a]Chi-square.
**p value <.01,

Further, the Fornell and Larcker (1981) criterion tests the square root of the average variance extracted towards the correlation between the construct and any of the other constructs. This test supports the divergent validity of the data. As an example, the average variance extracted for perceived greenwashing is .624, while the correlation between perceived greenwashing and blockchain information dimensions is lower, with a correlation coefficient of −.454, and a correlation coefficient of −.235 for monitoring costs.

Thereafter, we used the heterotrait–monotrait ratio of correlations (HTMT) technique to assess the discriminant validity of the latent constructs (Henseler et al., 2015). This technique measures the similarity between latent constructs. The analysis reports an HTMT value of .560 between perceived greenwashing and blockchain information dimensions, .117 between blockchain information dimensions and monitoring costs, and .267 between perceived greenwashing and monitoring costs. Since the values are clearly smaller than one, discriminant validity can be regarded as established. The model fit for the measurement model is satisfactory with a chi-square of 421.969 (226 df) (p value <.01). The CFI is .976, RMR .280, standardized RMR .042, and RMSEA .045, with a confidence interval between .038 and .052.

4.4 | Results

The results from the structural equation model are reported in Table 4. H1 stated that the blockchain information dimensions reduce the perceived greenwashing of ecological vegetables. The statistical test supports this prediction (H1: −.264, p value <.01). Next, H2 predicted that certification also reduces perceived greenwashing. The statistical test supports this hypothesis (H2: −.085, p value <.01). This supports the two main hypotheses in the research model. When comparing the standardized beta coefficients, we see that blockchain information dimensions have a score of −.403 compared to certification at −.178. The difference is significant (chi-square 8.402, p value <.001). This supports the notion that the information dimension

protects brands more strongly against perceived greenwashing. The explained variance for the full model is 28.2%. The model fit for the structural model is satisfactory with a chi-square of 421.969 (226 df) (p value <.01). The CFI is .976, RMR .265, standardized RMR .042, and RMSEA .045.

To test the robustness of the results, we ran a model where the missing data were replaced with the case-wise maximum likelihood technique. This is an EM type of computation for missing data (Jamshidian & Bentler, 1999). The missing data concern 63 cases with 22 patterns. The GLS combined test for homogeneity of means and covariances reports a significant chi-square of 1463.912 (1235 df) (p value >.01). The fit results report a chi-square of 394.403 (383 df) (p value <.01). The CFI is .980, RMR .256, standardized RMR .040, and RMSEA .041, with a confidence interval between .034 and .047. H1 is supported (H1: −.425, p value <.01), as well as H2 (H2: −.206, p value <.01) and H3 (chi-square 10.619, p value <.01).

The analysis results for the controls show that increased monitoring is instrumental to constrain perceived greenwashing. To conclude the analysis, although information, certification, and monitoring costs are intertwined governance structures to control perceived greenwashing, the results demonstrate an upside potential to apply state-of-the-art smart contracts using blockchain technology to produce transparent, traceable, and tamperproof information that reduces the level of perceived greenwashing.

5 | DISCUSSION

There has been significant research on the destructive consequences of greenwashing. However, little attention has been paid to the managerial aspect to control it. Therefore, our focus here has been to investigate the potential to support green growth through valid information in the market. Our results show that consumers appreciate transparent, traceable, and tamperproof information that supports their decisions. Consequently, our results point in a direction where blockchain technology applications can provide this information to consumers. Trustworthy consumer information throughout the supply chain will support the green transition to a more sustainable society. Perceived greenwashing, on the other hand, threatens the necessary disruptive sustainable change. We found that consumer access to trusted transparent, traceable, and tamperproof product information had a strong and significant effect that controlled perceived greenwashing.

Certifications are counteractive institutional structures whose purpose is to control lemon markets (Akerlof, 1970, p. 499). Our results support the effect of ecological certifications on the level of perceived greenwashing. Institutions are formal, such as certifications supported by laws, regulations, and enforcement. Certifications are institutions that are a "form of constraint that humans devise to shape human interaction" (North, 1990, p. 4). Hence, the ecological food certifications constrain the perceived greenwashing. According to the new institutional economy (North, 1990), the costly effect of greenwashing for consumers and society in general leads to institutional change in the direction of ecological certifications. Our findings support this perspective.

Finally, our findings show that monitoring efforts restrain the level of costly perceived greenwashing (Jensen & Meckling, 1976). When the consumer expects to buy ecological food, it is a complex and costly task to eliminate greenwashed products. The consumer–supply chain interaction is often characterized by complexity and information asymmetry. Thus, the supply chain is in a superior situation relative to the consumer (Bergen et al., 1992). The monitoring of the green capacity of the product therefore makes the consumer comfortable that less greenwashing takes place. Perceived greenwashing might be related to a linear economy culture where supply companies only change their market communication and do nothing to restructure their portfolio of nonsustainable products to transform their business to a circular green economy. Instead of demarketing old, nonsustainable products, they actively try to promote them as "green" (Armstrong Soule & Reich, 2015).

5.1 | Managerial implications

This investigation should inspire the manager of supply chains to realize that consumers want transparent, traceable, and tamperproof information to ensure the true quality of the transaction. Current state-of-the-art blockchain technology has the capacity to provide this information to consumers. This information might also support green communication, brands, and promotion in the green transition to the circular economy. Thus, the information that consumers acknowledge in this study might create a competitive advantage in the market growth of green products. Furthermore, our data indicate that certification systems pay off. Consumers trust certification systems that support their choice of green products. Management therefore should appreciate efforts to certify their business and products. Also, we find that monitoring is an essential tool that consumers apply to safeguard their green consumption of ecological food. The management therefore must embrace systems that facilitate information to reduce consumer-monitoring costs. Our research supports a managerial perspective on how companies should orchestrate efforts to fulfill the intertwined consumer need for information, certifications, and monitoring to reduce perceived greenwashing.

5.2 | Limitations and further research

This research is based on cross-sectional data. The data might reveal short-term outcomes based on theoretical predictions. We are therefore unable to test the long-term effect of unethical greenwashing behavior in a market. The longitudinal lemons problem of greenwashing as it leads to the disintegration of markets for green products has not yet been tested. On the other hand, our research supports the notion that certification might mitigate but not control the lemons problem in markets for green ecological food products. If we had had access to longitudinal data in a quasi-experimentally designed survey,

we could have analyzed the effects of time asymmetry between managerial variables like certification and information and the predicted outcome of perceived greenwashing. Also, this study is based on perceptual survey data, not a multi-method triangulation approach, where we added quantitative measures of sales (sales value, tons, revenue, etc.) of ecological vegetables and greenwashing (quantification of false communication). On the other hand, we interviewed consumers of ecological food products directly. Thus, the external validity of this study might present a good estimate of the real situation in the market. The data from Scandinavia might also supplement previous international studies of perceived greenwashing from other parts of the world (Table 1). The Scandinavian context is homogeneous, stable, and egalitarian (John & Reve, 1982). A stable empirical context reflecting the behavior of consumers of ecological products provides effective variation of theoretical variables that support the generalizability of the findings. It offers a ceteris paribus setting where testing the model is not exposed to a high risk of hidden and sporadic third variables. Also, the consumer market for ecological products is well established. We assume that the market for ecological food is a valid empirical context for testing the model.

Future studies of greenwashing should benefit from data from other markets, countries, and products. Also, managerial aspects like trustworthy information and certification systems are different in other contexts. Institutional systems like certifications are formal governance structures to control unethical behavior like greenwashing. However, there are other important informal structures like trust, norms, and culture that probably affect the ethics of perceived greenwashing as well. We therefore need more greenwashing research on both formal and informal managerial and institutional structures.

Perceived greenwashing hurts sustainable development globally because markets have become global and digital. We see a growing problem in digital markets because consumers cannot control their products before buying them, thus being a pretext for greenwashing. Digitalization of markets needs more inspection to learn how greenwashing might gain competitive advantage because of the information asymmetry between the supply chains and the uninformed consumers. Moreover, further research should investigate how certification systems can support the global trade of green products. Some problems related to the enforcement of property rights following the regulations of the World Trade Organization (n.d.) (Agreement on Trade-Related Aspects of Intellectual Property Rights) can reduce the effect of green certification systems, brands, and guarantees.

5.3 | Conclusions

Perceived greenwashing leads to a situation where consumers cannot pursue their intentional choice of buying green products in favor of unsustainable products. Following the logic of Akerlof's (1970) seminal paper, such lemons markets disintegrate over time and ultimately represent an existential threat to the transition to a green economy. Our findings indicate that information availability—transparent, traceable, and tamperproof information—significantly lessens the level of perceived greenwashing. Our study supports the argument that certifications are an effective counteractive institution that control unethical market opportunism like greenwashing. However, in an increasingly complex and global world of trade relationships, it becomes more difficult and costly to control and enforce certifications. Thus, a combination of legal enforcement of certification and access to information offered through blockchain technology can support consumers and add competitiveness to real sustainable products. Finally, we found that monitoring behavior in the market had a significant effect on perceived greenwashing in the market. Perceived greenwashing is a market dysfunctionality that threatens the green transition of global markets. We hope that our research inspires more research in this area.

ACKNOWLEDGEMENTS

The authors are listed at random as they contributed equally to the development of this article. We also acknowledge comments from participants at the SMS Special Conference in Oslo, June 2018, and at the Blockchain Technology & Organizations Research Symposium, University of Connecticut School of Business, Peter J. Werth Institute for Entrepreneurship & Innovation Stamford, CT, august 2018, on previous versions of this manuscript. Thanks to the MSc students Nicolai Lenouvel Hansen and Jasin Nordheim for their effort in the data collection.

ORCID

Arne Nygaard https://orcid.org/0000-0002-6179-4233

REFERENCES

Akerlof, G. (1970). The market for lemons. *Quarterly Journal of Economics*, *84*(3), 488–500. https://doi.org/10.2307/1879431

Armstrong Soule, C. A., & Reich, B. J. (2015). Less is more: Is a green demarketing strategy sustainable? *Journal of Marketing Management*, *31*(13–14), 1403–1427. https://doi.org/10.1080/0267257X.2015.1059874

Arndt, J. (1968). Word-of-mouth advertising and perceived risk. In *Perspectives in consumer behavior* (pp. 330–336). Scott Foresman.

Arya, V. (2019). How should businesses tap into growing green consumerism? Efforts must be made to remove the distrust that consumers have about the genuineness of green products and also their quality. *The Entrepreneur*, August 17.

Bergen, M., Dutta, S., & Walker, O. C. Jr. (1992). Agency relationships in marketing: A review of the implications and applications of agency and related theories. *Journal of Marketing*, *56*(3), 1–24. https://doi.org/10.1177/002224299205600301

Berrone, P., Fosfuri, A., & Gelabert, L. (2017). Does greenwashing pay off? Understanding the relationship between environmental actions and environmental legitimacy. *Journal of Business Ethics*, *144*(2), 363–379. https://doi.org/10.1007/s10551-015-2816-9

Callery, P. J., & Perkins, J. (2021). Detecting false accounts in intermediated voluntary disclosure. *Academy of Management Discoveries*, *7*(1), 40–56. https://doi.org/10.5465/amd.2018.0229

Chandler, A. D. (1962). *Strategy and structure: Chapters in the history of the American enterprise*. Massachusetts Institute of Technology Cambridge.

Chandler, A. D. (1990). *Strategy and structure: Chapters in the history of the industrial enterprise* (Vol. 120). MIT Press.

Coen, D., Herman, K., & Pegram, T. (2022). Are corporate climate efforts genuine? An empirical analysis of the climate 'talk–walk' hypothesis. *Business Strategy and the Environment*, *31*, 3040–3059. https://doi.org/10.1002/bse.3063

Dahlstrom, R., & Nygaard, A. (1995). An exploratory investigation of interpersonal trust in new and mature market economies. *Journal of Retailing*, *71*(4), 339–361. https://doi.org/10.1016/0022-4359(95)90018-7

De Vries, G., Terwel, B. W., Ellemers, N., & Daamen, D. D. (2015). Sustainability or profitability? How communicated motives for environmental policy affect public perceptions of corporate greenwashing. *Corporate Social Responsibility and Environmental Management*, *22*(3), 142–154. https://doi.org/10.1002/csr.1327

Delmas, M. A., & Burbano, V. C. (2011). The drivers of greenwashing. *California Management Review*, *54*(1), 64–87. https://doi.org/10.1525/cmr.2011.54.1.64

EU. (2021). Screening of websites for 'greenwashing': Half of green claims lack evidence. Press release: 28 January Brussels, https://ec.europa.eu/commission/presscorner/detail/en/ip_21_269

Fornell, C., & Larcker, D. F. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, *18*(1), 39–50. https://doi.org/10.1177/002224378101800104

Friedman, M. (1985). Consumer boycotts in the United States, 1970–1980: Contemporary events in historical perspective. *Journal of Consumer Affairs*, *19*(1), 96–117. https://doi.org/10.1111/j.1745-6606.1985.tb00346.x

Giddens, A. (1990). *The consequences of modernity*. Stanford University Press.

Global Slavery Index. (2018). Asia and the Pacific. https://www.globalslaveryindex.org/2018/findings/regional-analysis/asia-and-the-pacific/

Gupta, A. (2008). Transparency under scrutiny: Information disclosure in global environmental governance. *Global Environmental Politics*, *8*(2), 1–7. https://doi.org/10.1162/glep.2008.8.2.1

Heide, J. B., & Miner, A. S. (1992). The shadow of the future: Effects of anticipated interaction and frequency of contact on buyer-seller cooperation. *Academy of Management Journal*, *35*(2), 265–291. https://doi.org/10.2307/256374

Henseler, J., Ringle, C. M., & Sarstedt, M. (2015). A new criterion for assessing discriminant validity in variance-based structural equation modeling. *Journal of the Academy of Marketing Science*, *43*(1), 115–135. https://doi.org/10.1007/s11747-014-0403-8

Heras-Saizarbitoria, I., Boiral, O., & Díaz de Junguitu, A. (2020). Environmental management certification and environmental performance: Greening or greenwashing? *Business Strategy and the Environment*, *29*(6), 2829–2841. https://doi.org/10.1002/bse.2546

Hurst, J. W. (1956). *Law and the conditions of freedom in the nineteenth century United States*. University of Wisconsin.

Iansiti, M., & Lakhani, K. R. (2017). The truth about blockchain. *Harvard Business Review*, *95*(1), 118–127.

Jamshidian, M., & Bentler, P. M. (1999). ML estimation of mean and covariance structures with missing data using complete data routines. *Journal of Educational and Behavioral Statistics*, *24*(1), 21–41. https://doi.org/10.2307/1165260

Jensen, M. C., & Meckling, W. H. (1976). Theory of the firm: Managerial behavior, agency costs and ownership structure. *Journal of Financial Economics*, *3*(4), 305–360. https://doi.org/10.1016/0304-405X(76)90026-X

John, G., & Reve, T. (1982). The reliability and validity of key informant data from dyadic relationships in marketing channels. *Journal of Marketing Research*, *19*(4), 517–524. https://doi.org/10.1177/002224378201900412

Kim, H., & Laskowski, M. (2017). A perspective on blockchain smart contracts: Reducing uncertainty and complexity in value exchange. In 2017 26th International Conference on Computer Communication and Networks (ICCCN).

Klein, J. G., Smith, N. C., & John, A. (2004). Why we boycott: Consumer motivations for boycott participation. *Journal of Marketing*, *68*(3), 92–109. https://doi.org/10.1509/jmkg.68.3.92.34770

Luhmann, N. (2014). *Vertrauen*. UTB.

Mahoney, L. S., Thorne, L., Cecil, L., & LaGore, W. (2013). A research note on standalone corporate social responsibility reports: Signaling or greenwashing? *Critical Perspectives on Accounting*, *24*(4–5), 350–359. https://doi.org/10.1016/j.cpa.2012.09.008

Marquis, C., Toffel, M. W., & Zhou, Y. (2016). Scrutiny, norms, and selective disclosure: A global study of greenwashing. *Organization Science*, *27*(2), 483–504. https://doi.org/10.1287/orsc.2015.1039

McKinsey & Company. (2020). *The state of fashion 2020*. McKinsey & Company Report.

McKnight, H. D., & Chevarny, N. L. (2001-2002). What trust means in e-commerce customer relationships: An interdisciplinary conceptual typology. *International Journal of Electronic Commerce*, *6*(2), 35–59. https://doi.org/10.1080/10864415.2001.11044235

Natural Marketing Institute. (2021). Sustainability consumer trends report: State of sustainability in America. 19th Annual Consumer Insights & Trends Report.

Natural Marketing Institute. (2022). Sustainability consumer trends report: State of sustainability in America. 20th Annual Consumer Insights & Trends Report Consumer Trends Report.

North, D. (1990). *Institutions, institutional change, and economic performance*. Cambridge University Press.

Nygaard, A. (2022). From linear to circular economy: A transaction cost approach to the ecological transformation of the firm. *Circular Economy and Sustainability*, *2*, 1127–1142.

Nyilasy, G., Gangadharbatla, H., & Paladino, D. A. (2014). Perceived greenwashing: The interactive effects of green advertising and corporate environmental performance on consumer reactions. *Journal of Business Ethics*, *125*(4), 693–707. https://doi.org/10.1007/s10551-013-1944-3

Parguel, B., Benoît-Moreau, F., & Larceneux, F. (2011). How sustainability ratings might deter 'greenwashing': A closer look at ethical corporate communication. *Journal of Business Ethics*, *102*(1), 15–28. https://doi.org/10.1007/s10551-011-0901-2

Parguel, B., Benoit-Moreau, F., & Russell, C. A. (2015). Can evoking nature in advertising mislead consumers? The power of 'executional greenwashing'. *International Journal of Advertising*, *34*(1), 107–134. https://doi.org/10.1080/02650487.2014.996116

Rahman, I., Park, J., & Chi, C. G. Q. (2015). Consequences of "greenwashing": Consumers' reactions to hotels' green initiatives. *International Journal of Contemporary Hospitality Management*, *27*(6), 1054–1081. https://doi.org/10.1108/IJCHM-04-2014-0202

Rahman, S. U., & Nguyen-Viet, B. (2022). Towards sustainable development: Coupling green marketing strategies and consumer perceptions in addressing greenwashing. *Business Strategy and the Environment*, 1–14. https://doi.org/10.1002/bse.3256

Ramus, C. A., & Montiel, I. (2005). When are corporate environmental policies a form of greenwashing? *Business & Society*, *44*(4), 377–414. https://doi.org/10.1177/0007650305278120

Sallis, J. E., Gripsrud, G., Olsson, U. H., & Silkoset, R. (2021). *Research methods and data analysis for business decisions*. Springer.

Schmuck, D., Matthes, J., & Naderer, B. (2018). Misleading consumers with green advertising? An affect–reason–involvement account of greenwashing effects in environmental advertising. *Journal of Advertising*, *47*(2), 127–145. https://doi.org/10.1080/00913367.2018.1452652

Seele, P., & Gatti, L. (2017). Greenwashing revisited: In search of a typology and accusation-based definition incorporating legitimacy strategies. *Business Strategy and the Environment*, *26*(2), 239–252. https://doi.org/10.1002/bse.1912

Shankleman, J. (2021). Nearly half of eco-friendly product claims could be breaking law. *Bloomberg Green*, January 28.

Siano, A., Vollero, A., Conte, F., & Amabile, D. S. (2017). "More than words": Expanding the taxonomy of greenwashing after the Volkswagen scandal. *Journal of Business Research*, *71*, 27–37. https://doi.org/10.1016/j.jbusres.2016.11.002

Sky News. (2021). Al Gore: Greenwashing is 'rising threat' that could derail climate progress. Victoria Seabrook, climate reporter, Wednesday 14 July 2021 UK. https://news.sky.com/story/al-gore-greenwashing-is-rising-threat-that-could-derail-climate-progress-12355636

Smith, V. L., & Font, X. (2014). Volunteer tourism, greenwashing and understanding responsible marketing using market signaling theory. *Journal of Sustainable Tourism*, *22*(6), 942–963. https://doi.org/10.1080/09669582.2013.871021

Szabo, S., & Webster, J. (2021). Perceived greenwashing: The effects of green marketing on environmental and product perceptions. *Journal of Business Ethics*, *171*(4), 719–739. https://doi.org/10.1007/s10551-020-04461-0

The Economist. (2021). Sustainable finance is rife with greenwash: Time for more disclosure. May 22.

United Nations. (2014). *A guide to traceability: A practical approach to advance sustainability in global supply chains*. Global Compact Office, Two United Nations Plaza.

Van Rijswijk, W., & Frewer, L. J. (2008). Consumer perceptions of food quality and safety and their relation to traceability. *British Food Journal*, *110*(10), 1034–1046. https://doi.org/10.1108/00070700810906642

Williamson, O. E. (1973). Markets and hierarchies: Some elementary considerations. *The American Economic Review*, *63*(2), 316–325.

World Trade Organization. (n.d.) Intellectual property: Protection and enforcement. Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS), negotiated during the 1986–94 Uruguay Round, introduced intellectual property rules. https://www.wto.org/english/thewto_e/whatis_e/tif_e/agrm7_e.htm

Xingqiang, D. (2015). How the market values greenwashing? Evidence from China. *Journal of Business Ethics*, *128*(3), 547–574. https://doi.org/10.1007/s10551-014-2122-y

Yiannas, F. (2018). A new era of food transparency powered by blockchain. *Innovations: Technology, Governance, Globalization*, *12*(1–2), 46–56. https://doi.org/10.1162/inov_a_00266

Zhang, L., Li, D., Cao, C., & Huang, S. (2018). The influence of greenwashing perception on green purchasing intentions: The mediating role of green word-of-mouth and moderating role of green concern. *Journal of Cleaner Production*, *187*, 740–750. https://doi.org/10.1016/j.jclepro.2018.03.201

Zucker, L. G. (1986). Production of trust: Institutional sources of economic structure, 1840–1920. *Research in Organizational Behavior*, *8*, 53–111.

How to cite this article: Nygaard, A., & Silkoset, R. (2022). Sustainable development and greenwashing: How blockchain technology information can empower green consumers. *Business Strategy and the Environment*, 1–13. https://doi.org/10.1002/bse.3338

APPENDIX A

TABLE A1 Operationalizations and measures

Constructs	
Greenwashing	
Q1	I am unsure if ecological vegetables are ordinary vegetables sold as ecological.
Q2	It is extremely difficult to know for sure if ecological vegetables are what they claim to be.
Q3	It is difficult for me to know whether ecological vegetables are in fact ecological.
Q4	It is difficult for me to evaluate whether ecological vegetables are in fact ecological.
Transparent information	
I am certain that I can get access to all information about vegetables that are:	
Q1	Relevant for my purchase
Q2	Important for my purchase
Q3	Crucial for my purchase
Traceable information	
I completely trust in the traceability of vegetables':	
Q1	Production methods
Q2	Expiry date
Q3	Geographical origin
Q4	Nutrition content
Tamperproof information	
I completely trust that the information about vegetables has never been:	
Q1	Manipulated
Q2	Falsified
Q3	Tampered with

TABLE A1 (Continued)

Constructs	
Q4	Cheated with
Blockchain information dimensions—higher order construct:	
	Transparent information
	Traceable information
	Tamperproof information
Certification	
Q1	Familiarity with certification schemes for ecological vegetables
QR code information	
Q1	Familiarity with product information through QR codes
RFID information	
Q1	Familiarity with product information through RFID information
Monitoring costs	
In purchasing ecological vegetables:	
Q1	It is a waste to use more time assessing whether they are similar to ordinary vegetables. *
Q2	It is a bad use of time to assess whether they are exactly like ordinary vegetables. *
Q3	It is an unnecessary usage of time because they are exactly like ordinary vegetables. *
Q4	It is a waste of time because they are exactly like ordinary vegetables. *
Practice	
Q1	Percentage of those who bought vegetables that are ecological
Sales channel	
Q1	Share of products bought at farmers' markets vs. grocery stores