Received 12 September 2023
Revised 16 November 2023
12 December 2023
Accepted 15 December 2023

Consumers' valuation of blockchain-based food traceability: role of consumer ethnocentrism and communication via QR codes

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Abstract

Purpose – This study aims to investigate the impact of consumer ethnocentrism on consumers' evaluation of blockchain-based traceability information. It also examined how the use of quick response (QR) codes for traceability affects consumers' evaluation of traceable food products.

Design/methodology/approach – An online choice experiment was conducted to determine consumers' evaluation of the blockchain-based traceability of Feta cheese with a quota sample of 715 Greek consumers. Pearson bivariate correlation and mean comparison were used to examine the relationship between consumer ethnocentrism and QR use behaviour. Random parameter logit models were employed to examine consumers' valuation of the examined attributes and interaction terms.

Findings – The results show that ethnocentric consumers are willing to pay more for blockchain-based traceability information. Ethnocentric consumers tend to scan QR codes with traceability information. Spending more time reading traceability information embedded in QR codes does not lead to a higher willingness-to-pay (WTP) for traceable food products.

Practical implications – The findings suggest that patriotic marketing messages can draw consumers' attention to blockchain-based traceability information. The modest WTP for and low familiarity with blockchain-based traceability systems raise the need for educating consumers regarding the benefits of blockchain in traceability systems.

Originality/value – This is the first study to provide timely empirical evidence of a positive WTP for blockchain-based traceability information for a processed dairy product. This study is the first to attempt to distinguish the effects of the intention to scan QR codes and reading information embedded in QR codes on consumers' valuation of food attributes.

Keywords Food traceability, QR code, Blockchain, Consumer ethnocentrism, Willingness-to-pay, Dairy

Paper type Research paper

1. Introduction

By providing transparent information on the origin of food ingredients, food quality and safety control throughout the production process, from farm to fork, food traceability is one of the main solutions to consumer concerns about food fraud (Qian *et al.*, 2020; Ringsberg, 2014;

Funding: This article is supported by the FAIRCHAIN project which has received funding from the EU's Horizon 2020 research and innovation program under grant agreement No 101000723.

British Food Journal
Vol. 126 No. 13, 2024
pp. 72-93
Emerald Publishing Limited
0007-070X
DOI 10.1108/BFJ-09-2023-0812

du Plessis and Gerrie, 2012). Several developed countries such as the European Union (EU), the United States of America (USA), Australia, Canada, etc. already required food traceability as a mandatory requirement for food enterprises (Charlebois *et al.*, 2014). However, in most cases, the regulations only require records of direct suppliers and buyers of a food operator or in other words, a "one-step forward, one-step backward" traceability system (Charlebois *et al.*, 2014). In theory, consumers can therefore only access the traceability information of direct sellers/retailers and not that of primary producers. In the meantime, recent studies have shown that consumers are increasingly demanding more transparency in agri-food supply chains (Hou *et al.*, 2020; Vriezen *et al.*, 2023). The increased demand for transparency in the food supply chain is motivating food chain actors to utilise more advanced technologies to improve their traceability systems (Latino *et al.*, 2022; Mattevi and Jones, 2016).

Blockchain appears to have several merits in advancing food traceability systems (Collart and Canales, 2021; Astill *et al.*, 2019). Recent pilot projects have shown that blockchain provides an immutable and standardised database for traceability systems, which potentially increases the efficiency of supply chain management and interoperability amongst chain actors whilst ensuring greater transparency in the food supply chain (Kamath, 2018; Casino *et al.*, 2020). Blockchain-based traceability systems are novel to many supply chains and the implementation of such a system will inevitably be costly. Hence, it is crucial to prove whether the adoption of blockchain-based traceability systems would be profitable by assessing consumers' willingness-to-pay (WTP) for it. As the application of this technology is mostly in the proof-of-concept and early commercial stages, understanding of the factors influencing consumers' valuation of its applications remains scant. A few recent studies in the USA and China indicated a positive consumers' valuation of blockchain-based traceability systems (Lin *et al.*, 2022; Shew *et al.*, 2021; Zhai *et al.*, 2023). However, consumers' valuation of blockchain-based traceable products may vary by country, product and other contexts. This study is one of the first attempts to investigate the preference of European consumers for blockchain-based traceability systems.

In addition to the benefit of ensuring the transparency and authenticity of information, recent projects using blockchain in agri-food supply chains also seek to provide consumers with direct access to traceability information (Latino *et al.*, 2022). These projects have often used quick response (QR) codes as a means of communication, allowing consumers to scan such codes on food packaging and redirect to a mobile application or website to view or even verify traceability information (Gatteschi *et al.*, 2020). Even before the introduction of blockchain-based traceability systems, QR codes on food packaging were a popular means of communicating traceability information (Bradford *et al.*, 2022; Kim and Woo, 2016). QR codes can store substantially more information than a one-dimensional code (i.e. a bar code), whilst they can embed different types of information such as text, video, advertisements, or website links (Ozkaya *et al.*, 2015). QR codes are especially revolutionary for food labelling design, as they allow marketers to provide more detailed information, such as traceability information, to consumers in a relatively small space on food packaging (Ozkaya *et al.*, 2015).

Traceability systems provide comprehensive information about the production and procurement of products and allow consumers to determine the origin of products, their ingredients and claims of traditional production (Van Rijswijk and Frewer, 2012). Consequently, consumer ethnocentrism, which refers to the tendency to favour local products over imported ones (Shimp and Sharma, 1987), can potentially account for consumers' valuation of traceable food products. Previous studies have demonstrated that consumer ethnocentrism is a valuable tool to explain consumer preferences (Fernandez-Ferrın *et al.*, 2020; Maró *et al.*, 2023) and customer segmentation in the food industry (Chryssochoidis *et al.*, 2007). Fernández-Ferrín *et al.* (2018) indicated that ethnocentric consumers exhibit a particular preference for food products that are made from local

ingredients, are produced using traditional methods and are associated with regional identity.

This study aims to achieve two objectives. Firstly, it seeks to investigate the influence of scanning QR codes and reading traceability information embedded in the codes on consumers' valuation of traceable food products. Secondly, it aims to determine the impact of consumer ethnocentrism on consumers' valuation of blockchain-based traceability information. An online choice experiment was conducted using a sample of Greek consumers, focussing specifically on Feta cheese. To comprehensively evaluate consumers' valuation of traceability information within a multi-attribute context, following the recommendations of Van Loo *et al.* (2019), this study examines consumers' valuations for Protected Designation of Origin (PDO) certification, blockchain-indication labels as an enabling technology for traceability systems, a QR code with embedded traceability information and a generic QR code with company information.

2. Theoretical background and literature review

2.1 Impact of consumer ethnocentrism on consumers' valuation

Shimp and Sharma (1987) introduced the concept of consumer ethnocentrism, which reflects normative beliefs about the appropriateness of buying products from one's own country as opposed to buying imported products. Highly ethnocentric consumers tend to favour domestic products over imported products due to their affinity to their home country and their need to fulfil their cultural identity (Lusk *et al.*, 2006; Banovic *et al.*, 2019). Shimp and Sharma (1987) developed a measurement scale called CETSCALE, which comprises 17 items and is a psychometrically sound tool for assessing consumers' ethnocentric tendencies. The full and shortened versions of the CETSCALE have proven their validity and reliability in measuring consumer ethnocentrism in different contexts (Van Loo *et al.*, 2019). Based on a meta-analysis by Guo and Zhou (2017), 60 studies confirmed that consumer ethnocentrism has a positive influence on consumers' valuation of domestic products compared to foreign products.

In addition to its focus on consumer preference for the country-of-origin of products, consumer ethnocentrism has also been used to explain customer segmentation (Seitz and Roosen, 2015) and consumer preference for unfamiliar (Aqueveque, 2015) or ethnic foods (Camarena *et al.*, 2011). Vanhonacker *et al.* (2010) conducted a large pan-European consumer survey and demonstrated that European consumers with a higher level of ethnocentrism tend to exhibit a preference for traditional foods. Chryssochoidis *et al.* (2007) found that ethnocentric Greek consumers showed a stronger preference for Greek products such as yoghurt, yellow cheese and beer than their less ethnocentric counterparts. Similarly, Fernández-ferrín *et al.* (2018) found that Spanish ethnocentric consumers value products that are traditionally produced, particularly appreciating protected geographical products such as cheese and wine. Despite the wide range of applications of consumer ethnocentrism in the existing literature, to the best of the authors' knowledge, no previous academic research has investigated the relationship between consumer ethnocentrism and consumers' valuation of food traceability. Since traceability information can indicate the locality and traditionality of food products, we hypothesise the following:

H1. Consumer ethnocentrism has a positive influence on consumers' valuation of blockchain-based traceability information.

2.2 Consumers' valuation of QR codes

The use of QR codes has grown considerably in popularity over the last decade. According to a report by Mobileron, a mobile-centric security platform, 84% of surveyed individuals in the

USA had scanned a QR code at least once in 2020, with 32% reporting having scanned a QR code on product packaging in the previous six months (Businesswire, 2020). Another survey conducted in 2020 in the USA, the United Kingdom (UK), Germany, the Netherlands and France revealed that 32% of 2,197 respondents had scanned a QR code in the last week (Statista, 2021). The use of QR codes experienced exponential growth during the COVID-19 pandemic due to the need for contactless contact tracing (Statistia, 2023). Despite the increased overall usage rates in recent years, the specific use of QR codes on food packaging remains limited in many countries (Spence *et al.*, 2018; Yang *et al.*, 2022).

The adoption of QR codes on food packaging has been studied using the Theory of Planned Behaviour (Bradford *et al.*, 2022; Ozkaya *et al.*, 2015) and Technological Acceptance Modelling (Kim and Woo, 2016), which have primarily focussed on explaining the intention to adopt QR codes. Kim and Woo (2016) demonstrated that consumers are more willing to scan a QR code on food packaging if they perceive the embedded information to be informative and helpful in their purchase decisions.

Few studies have investigated consumers' valuation of food traceability information embedded in QR codes. Nugraha *et al.* (2021) and Wu *et al.* (2020) found that Chinese consumers are willing to pay a significant price premium for products labelled with QR codes containing traceability information. However, these studies focussed on the presence of QR codes on the packaging without considering whether consumers scanned the QR codes and read the embedded information. Rotsios *et al.* (2022) observed differences in product knowledge between consumers who scan QR codes on food packaging and those who did not, but they did not assess the impact of scanning intention on consumers' valuation of the examined food product. To the best of the authors' knowledge, no studies have investigated the impact of scanning QR codes on food packaging on consumers' valuation of food products. Since scanning QR codes can help consumers access more detailed product information which can help consumers make more informed decisions (Rotsios *et al.*, 2022), we hypothesise:

H2. Scanning the QR code containing food traceability information is associated with higher consumers' valuation of traceable food products.

Furthermore, the time consumers spend reading the QR-embedded information might impact consumers' valuation. Previous studies primarily measured the impact of survey response time on consumers' valuation and found that the longer the response time is, the more precise the estimate of consumers' valuation is (Börger, 2016; Campbell *et al.*, 2017). To the best of the authors' knowledge, the association between the time spent reading QR-embedded information and consumers' valuation has not been scientifically investigated. Based on this literature gap, the following hypothesis was developed:

H3. A longer time spent reading QR-embedded traceability information is associated with higher consumers' valuation of traceable food products.

Similar to Hypothesis 1, ethnocentric consumers may have a greater interest in traceability information, as such information can indicate the locality and traditionality of food products, and this consumer segment often favours local and traditional foods (Yildiz *et al.*, 2018; Fernández-ferrín *et al.*, 2018). As traceability information is often embedded in QR codes on food packaging (Latino *et al.*, 2022), ethnocentric consumers may tend to scan such codes to obtain more product information to seek authentic local and traditional products. Therefore, we hypothesise that.

H4. Highly ethnocentric consumers are more likely to scan a QR code that contains traceability information than less ethnocentric consumers.

Similarly, ethnocentric consumers may also spend more time reading the traceability information embedded in the QR code due to their interest in the origin and traditional production methods of food (Fernández-ferrín *et al.*, 2018). Hence, we hypothesise that.

H5. Highly ethnocentric consumers are more likely to spend more time reading the traceability information embedded in QR codes than less ethnocentric consumers.

Our research makes valuable contributions to the existing literature by investigating the influence of ethnocentrism on consumers' valuation of traceability information (H1) and behaviour of using QR codes embedded with traceability information (H4, H5). Also, this study distinguishes the effects of scanning QR codes (H2) and reading QR-embedded information (H3) on consumers' valuation of food products, which adds to the knowledge of consumers' purchase decision process regarding the use of QR codes. The summary of the hypotheses can be found in Figure 1. In this study, a choice experiment was conducted to assess consumers' valuation of traceable food. The experimental design also included blockchain as the enabling technology for traceability systems to shed light on consumers' valuation of this innovative technology in the food sector, an area that has received limited and only recent attention in current literature (Shew *et al.*, 2021; Lin *et al.*, 2022).

3. Materials and methods

A choice experiment was used to investigate consumers' valuation of food traceability information embedded in QR codes. Besides, labelling schemes of PDO, blockchain, a QR code for general company information and prices were examined to create a multi-attribute context for the choice experiment setting (Van Loo *et al.*, 2019).

3.1 Research product and attribute choice

3.1.1 Feta cheese. Dairy products hold a significant position in the diet of Greek consumers, with relatively low elasticity in terms of selling prices and disposable income (Manolopoulou *et al.*, 2018). In Greece, soft cheeses constitute the majority (74.3%) of cheese production and were the most consumed type of cheese in 2017 (ICAP Group, 2019). Feta cheese, the main soft cheese, accounts for nearly 70% of cheese consumption in Greece (Vlachos, 2014). Given the crucial role of Feta cheese in traditional Greek cuisine, it was selected as the focal product in this study to examine the impact of consumer ethnocentrism on their valuation of traceable foods.

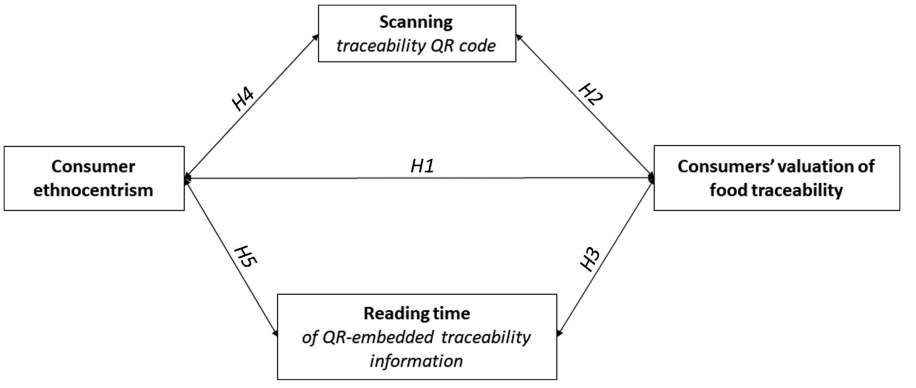


Figure 1.
Summary of hypotheses

Source(s): Authors' work

3.1.2 PDO (Protected Designation of Origin). Since 2002, Feta cheese has been certified as a PDO product under Greek and European legislation. The production of PDO Feta cheese requires the use of sheep's milk or a combination of sheep's milk (at least 70%) and goat's milk (up to 30%) from specific regions in Greece (Katsouri *et al.*, 2020). The use of imported milk is prohibited in PDO cheese production, and the cheese maturation process must take place in facilities located within defined geographical areas (Tsakalou and Vlahos, 2018). However, Feta cheese has unfortunately been a target of food fraud. Pidiaki *et al.* (2016) reported that 14 out of 34 samples of inspected Feta cheese in Thessaly, Greece were adulterated with cow milk. Additionally, dairy farmers have raised concerns about the illegal use of imported sheep milk to produce Feta cheese in order to reduce production costs (Tsakalou and Vlahos, 2018). Given the history of food fraud incidents associated with PDO Feta cheese, it is of interest to investigate whether consumers value authenticity technologies such as blockchain and QR codes for traceability information, which provide more transparent and reliable food traceability information compared to established certifications.

3.1.3 Blockchain. The application of blockchain is especially critical in the case of Feta cheese given the complexity of its supply chain and recent food fraud. Besides, the production of Feta cheese PDO requires certain steps by law, which can be incorporated into the smart contracts empowered by blockchain technology (Gésan-Guiziou *et al.*. 2022).

3.1.4 QR codes. In addition to the main focus of this study on QR codes carrying traceability information, an examination of QR codes that link to the company website was also conducted. This aspect aims to replicate a real-life scenario where some companies use QR codes on food packaging to provide general information about the company, similar to the study design implemented by Rotsios *et al.* (2022) for a dairy company. The comparison between consumers' valuation of the QR code with traceability information and the company QR code can provide insights into the significance of the QR code's content, rather than solely evaluating the impact of its presence on food packaging.

3.2 Experimental design

A discrete choice experiment (DCE) was chosen to elicit consumers' valuation of Feta cheese traceability. DCE is a hypothetical method that assumes (1) a good or service is constructed from a bundle of attributes that contribute to customers' utility (Lancaster, 1966), and (2) customers are rational when making a purchase decision in the sense that they would buy a product that has a maximised utility for them (McFadden, 1974).

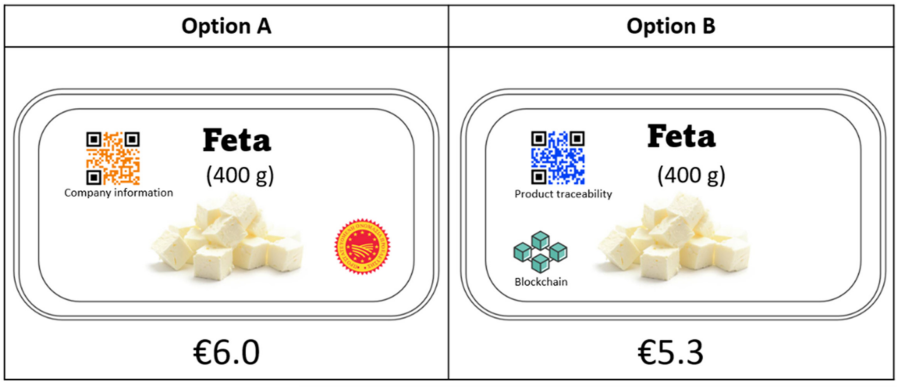
In this study, the profile of Feta cheese is displayed with four attributes namely (1) the presence of the PDO certification label, (2) the application of blockchain-based traceability, (3) the presence of QR codes (either QR codes for company information or QR codes for product traceability) and (4) prices with four levels. An explanation of the product characteristics was provided to the respondent (Table 1). A pilot survey ($n = 22$) with university students was launched to obtain the Bayesian priors needed to perform an efficient design for DCE (Traets *et al.*, 2019). The final design encompassed 16 choice sets, which were divided into two blocks. Only one block of choice sets (i.e. eight choice sets) was shown to each respondent to avoid cognitive burdens (Bech *et al.*, 2011) and the choice sets were randomised to avoid order bias (Day *et al.*, 2012). Each choice includes two options A and B of a Feta cheese product of 400 grams, and the opt-out option, meaning not choosing either options A or B (See Figure 2). The inclusion of the opt-out options is to avoid the effects of forced choices, which can inflate the estimates of consumers' valuation of some attributes (Dhar and Simonson, 2003).

Before starting to fill in the choice experiment questions, respondents were asked whether they wanted to scan a QR code to get more detailed information about the Feta cheese. If respondents agreed to scan the QR code, a page containing extra traceability information was shown providing details about (1) the identities and locations of breeders who provided milk

Attributes	Attribute level	Descriptions
Price (400g feta cheese)	€ 5.0; 5.3;5.6;6.0	
PDO		**Production Designation of Origin (PDO)** logo indicates that the product is produced in geographical areas of mainland Greece and Lesbos Prefecture and follows European quality and safety specifications to ensure the authenticity of feta cheese.
Blockchain	Blockchain	**Blockchain claim** guarantees that the information concerning Feta cheese production is recorded and stored in a blockchain system, in which it cannot be changed or deleted, protecting its integrity.
QR codes	Company information	This **QR** provides general information about the company that made the product and how feta cheese is generally made in this company.
	Product traceability	This **QR** provides specific information about the product in front of you, indicating the actual time and duration of each production step, and actual quality control, information about the actual breeders providing milk for this cheese production.

Source(s): Authors work

Table 1.
Attribute explanation



Note(s): All the illustrations in the choice experiments were translated into Greek languages in the official survey. Besides, two illustrated options, an option of "Choosing neither Option A nor Option B" was also provided to respondents

Source(s): Authors' work

Figure 2.
The example of a choice set

for Feta cheese production and (2) the production phases and the corresponding tests for each stage (see Supplementary Material). The duration of reading the additional information page was recorded for further analysis.

3.3 Participants

The participants of the study were Greek adults (over 18 years old) who were given informed consent before answering the questionnaire. The survey was developed in English and then translated into Greek. The final questionnaire in Greek language was administered using Qualtrics via a consumer panel of a market research agency, with a quota sampling approach for gender and age groups in Greece.

In total, the survey was distributed to 916 respondents. After removing incomplete responses (108), removing responses with missing data due to the selection of "prefer not to say" in the socioeconomic section (76) and removing consumers who did not consume Feta cheese (17), a final sample of 715 responses was retained for further analysis. The surveyed respondents were predominantly female (>70%). The unbalanced sample with more female respondents was due to the exclusion of incomplete responses and those who never buy Feta cheese. Most of the respondents were responsible or co-responsible for household food shopping, which fits well within the scope of this study on food purchase behaviour. Most of the surveyed participants (71%) were familiar with the concept of scanning QR codes, whilst only 12% indicated that they were familiar with the application of blockchain on food traceability. More details on the sample characteristics can be found in Supplementary Material.

3.4 Measuring consumer ethnocentrism

Consumer ethnocentrism was measured with a subset of seven items of the CETSCALE developed by Shimp and Sharma (1987). Respondents were asked to what extent they agreed with the seven statements on a five-point Likert scale (Table 2). The mean of all seven items was computed after checking Cronbach's alpha for the good reliability of scales (Table 2). The sample was split into two subgroups: a high ethnocentric group and a low ethnocentric group based on the median value of consumer ethnocentrism (median = 4), similar to the approach suggested by Van Loo *et al.* (2019) and Chryssochoidis *et al.* (2007).

4. Data analysis

4.1 Analysis of the impact of consumer ethnocentric and scanning the QR code with traceability information

To examine the impacts of consumer ethnocentrism on scanning a QR code with traceability information (Hypothesis 4) and reading time of traceability information (Hypothesis 5), two

	Mean (SD)	(Very) disagree[1]	(Very) agree[1]
Greek people should buy Greek-made products instead of imports	3.96 (1.04)	7.97%	69.09%
Only those products that are unavailable in Greece should be imported	3.73 (1.16)	15.10%	59.86%
Buy Greek-made products. Keep Greece working	4.25 (0.94)	5.03%	80.56%
Greek products, first, last, and foremost (always)	3.80 (1.09)	10.91%	63.22%
It is always better to purchase Greek products	4.00 (1.04)	8.25%	70.63%
There should be very little trading or purchasing of goods from other countries unless out of necessity	3.47 (1.17)	19.02%	48.53%
We should buy from foreign countries only those products that we cannot obtain within our own country	3.78 (1.13)	12.73%	61.40%
Average[2] of all 7 items	3.85 (0.87)		

Note(s): [1] The frequencies/percentages of the middle points were not shown in the table but can be retrieved by subtracting the percentages of the negative and positive points
[2] Cronbach's alpha (0.91) shows good reliability of the scale
Source(s): Authors' work

Table 2. Measurement of consumers' ethnocentrism with a five-point Likert scale (n = 715)

analyses were conducted. First, two ethnocentric groups concerning the means of variables *Scanning* and *Reading time* were compared using *t*-tests. *Scanning* is a dummy variable, which takes the value of 1 when respondents chose to scan the traceability code and 0 when otherwise. *Reading time* is a continuous variable accounting for the reading duration of the extra information page when respondents scanned a traceability QR code. For those who did not choose to scan the QR code, the value of *Reading time* is equal to 0. An illustrative explanation for variables *Scanning* and *Reading time* can be found in Figure 3. Second, the Pearson bivariate correlations between consumer ethnocentrism and the variables *Scanning* and *Reading time* were examined.

4.2 Impact of consumer ethnocentrism on consumers' valuation of food traceability embedded in QR codes

To address Hypotheses 1, 2 and 3, the choice data were analysed by using random parameter logit (RPL) models in R packages *mlogit* and *gmnl* (Sarrias *et al.*, 2020). RPL models estimate the utility coefficients of the examined attributes whilst considering the presence of preference heterogeneity amongst respondents (Hess and Stathopoulos, 2013; Greene and Hensher, 2010). Three RPL models were used for the choice analysis. Model 1 estimated the main effects of the examined four attributes in the choice experiment. The product utility (U) that an individual i obtains from alternative j at the choice situation t can be illustrated in Model 1 as shown below with ε_{ijt} accounting for the unobserved random errors term.

Model 1:

$$U_{ijt} = \beta_0 Opt\_out_{ijt} + \beta_{1,i} PDO_{ijt} + \beta_{2,i} Blockchain_{ijt} + \beta_{3,i} Company\ QR_{ijt} + \beta_{4,i} Trace\ QR_{ijt} + \beta_5 Price_{ijt} + \varepsilon_{ijt} \quad (1)$$

Opt_out is the variable that has the value of 1 when respondents chose an opt-out option and 0 otherwise. β_0 is an alternative-specific constant (ASC) representing the opt-out option. The variables of *PDO, Blockchain, Company QR and Trace QR* entered the models as dummy variables, which have the value of 1 when the attributes were presented in the alternative's profile and 0 when otherwise. $\beta_{1\text{-}5}$ are the coefficients of the examined attributes. Except for *Price*, all the attributes were presumed normally distributed.

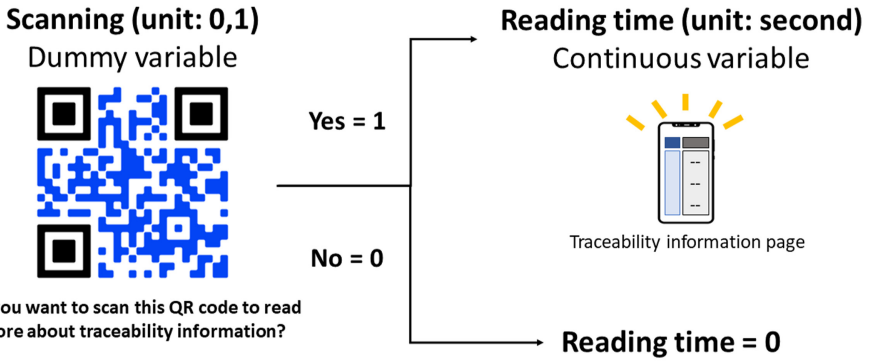


Figure 3.
Illustration of explanatory variables scanning and reading time

Source(s): Authors' work, the traceability information page used in the survey can be found in Supplementary Materials

To investigate the effect of consumer ethnocentrism and scanning QR codes on consumers' valuation of QR codes with traceability information, the interaction terms between the *Trace QR* and the ethnocentrism variable as well as the scanning QR variable were included in Model 2. Model 2 was essentially like Model 1, but in Model 2, $\beta_{4,i}$ represents for *Trace QR* variable can be explained with variables $Ethnogroup_i$ and $Scanning_i$ as shown below in Formula (2). $Ethnogroup_i$ is a dummy variable, which takes the value of 1 when the individual i is in the high ethnocentric group and 0 when otherwise. $Scanning_i$ is the value of *Scanning* which corresponds to individual i. Besides, π_{41} and π_{42} are the coefficients of the interactions between the *Trace QR* with $Ethnogroup_i$ and $Scanning_i$ respectively.

$$\beta_{4,i} = \beta_4 + \pi_{41} Ethnogroup_i + \pi_{42} Scanning_i + \sigma_4 \eta_{4i} \quad (2)$$

Model 3 is similar to Model 2 but substituted the variable $Scanning_i$ with $Reading\ time_i$, in which $Reading\ time_i$ is the value of *Reading time* of individual i.

All models were estimated with 1,000 Halton draws. Goodness-of-fit indicators, namely Akaike's information criteria (AIC), Bayesian information criteria (BIC) and log-likelihoods were also assessed.

5. Results and discussion

5.1 Relation between consumer ethnocentrism and scanning QR codes

Table 3 shows the mean comparisons of variables *Scanning* and *Reading time* between two groups of high ethnocentric consumers and low ethnocentric consumers. Table 4 examines the correlation between consumer ethnocentrism and (1) *Scanning* and (2) *Reading time*. Since respondents who did not choose to scan the traceability QR code (*Scanning* = 0) also were not shown the traceability information page to read (thus, *Reading time* = 0), a subgroup (n = 531) containing only respondents who chose to scan the QR code was used to analyse the mean comparison (in Table 3) and correlations (in Table 4) to avoid sampling bias.

The results of the mean comparisons (Table 3) and Pearson bivariate correlations (Table 4) showed that highly ethnocentric respondents were more likely to scan a QR code with traceability information (positive mean difference = 0.06, p-value = 0.047 and r = 0.11, p-value = 0.004), which confirmed Hypothesis 4. However, consumer ethnocentrism did not significantly correspond with a change in reading time of additional traceability information

	Sample	n	High ethnocentric group	n	Low ethnocentric group	Mean difference	t-test (p-value)
Scanning[b]	Total sample (n = 715)	402	0.78 (0.42)	313	0.71 (0.45)	0.06	0.047
Reading time[c]	Total sample (n = 715)	402	18.48 (49.73)	313	21.40 (102.89)	−2.91	0.645
Reading time	Only QR scanners (n = 531)[d]	244	23.70 (55.23)	287	29.97 (120.77)	−6.26	0.456

Note(s): [a] Low ethnocentric group is those who scored below the median of the consumer ethnocentrism variable, while the other is the high ethnocentric group. [b] Scanning (dummy variable) takes the value of 1, when respondents chose to scan the traceability QR code, and 0 otherwise. [c] Reading time (continuous variable) accounts for the reading time of the extra traceability information page if respondents chose to scan the traceable QR code. [d] Reading time is equal to 0 if the respondents did not choose to scan, the only QR scanners sample excludes those who did not scan the QR code

Source(s): Authors' work

Table 3. Mean comparisons of scanning QR and reading time between 2 groups of high ethnocentric and low ethnocentric respondents[a]

embedded in the QR code, both in the total sample and the subsample of QR scanners as shown in Table 3 and Table 4 (p-value >0.05), thus rejecting Hypothesis 5.

Previous studies have shown that ethnocentric consumers are collectively keen on the origin of products (Van Loo *et al.*, 2019), local foods (Guo and Zhou, 2017) and traditional foods (Fernández-ferrín *et al.*, 2018). As the traceability QR code contains information regarding the locality and traditionality of food products, it was not surprising that ethnocentric consumers also favoured scanning QR codes to obtain more traceability information as proven in this study. However, it is worth noting that even ethnocentric consumers would not spend more time reading traceability information embedded in QR codes than other consumer segments. This finding emphasises the need for concise communication even when additional traceability information is embedded in QR codes. The focus on the time of reading QR-embedded information filled the gap in the literature that mostly examined the response duration as the main time-related variable to explain choice experiment results (Vista *et al.*, 2009).

5.2 Choice analysis

5.2.1 Consumers' valuation of Feta attributes. The results of the three RPL models are displayed in Table 5. As expected, price coefficients were significant and had an expected negative sign across the three models, indicating that respondents preferred a low price. The opt-out coefficients were also significantly negative, implying that consumers gained a higher utility by buying the examined Feta cheese than by not buying it. Besides, the surveyed Greek consumers expressed a significant preference for Feta cheese products that have the labels of PDO certification, blockchain technology indication and QR codes. The significant standard deviations of the *Trace QR* parameter indicated the presence of preference heterogeneity amongst the respondents for this attribute. Meanwhile, Model 1 did not detect the preference heterogeneity amongst respondents for PDO, blockchain and company QR codes; thus it was not of interest to examine the effects of *Ethnogroup*, *Scanning* and *Reading time* variables in explaining consumers' valuation heterogeneity for these attributes in Models 2 and 3.

The marginal WTP for PDO certification is the highest amongst the examined attributes (€0.769), closely followed by the traceability information embedded in the QR code (€0.755) as shown in Table 6. QR code with company information generated a lower price premium (€ 0.562) compared to its traceability counterpart. Lastly, blockchain labelling gained the lowest marginal WTP (€ 0.264) amongst the examined attributes.

The positive valuations for PDO certifications were well-documented in the literature (see the review of Grunert and Aachmann (2016)). The high valuation for the PDO certification by Greek consumers was not surprising as the penetration of the PDO and Protected

	Sample	Correlation	p-value
Scanning[a]	Total sample (n = 715)	0.11	0.004
Reading time[b]	Total sample (n = 715)	0.03	0.432
Reading time	Only QR scanners (n = 531)[c]	0.02	0.687

Note(s): [a] Scanning (dummy variable) takes the value of 1, when respondents chose to scan the traceability QR code, and 0 otherwise. [b] Reading time (continuous variable) accounts for the reading time of the extra traceability information page if respondents chose to scan the traceable QR code. [c] Reading time is equal to 0 if the respondents did not choose to scan, the only QR-scanners sample excludes those who did not scan the QR code

Source(s): Authors' work

Table 4.
Bivariate correlations with consumer ethnocentrism

		Model1		Model2		Model3	
		β	SE	β	SE	β	SE
Price		−1.34	0.09***	−1.34	0.09***	−1.35	0.09***
Opt-out		−8.22	0.47***	−8.21	0.47***	−8.23	0.48***
PDO	Mean	1.03	0.06***	1.03	0.06***	1.04	0.50***
	SD	0.01	0.48	0.00	0.76	0.00	0.49
Blockchain	Mean	0.36	0.04***	0.36	0.04***	0.36	0.04***
	SD	0.04	0.76	0.05	0.75	0.06	0.85
Company QR	Mean	0.76	0.06***	0.76	0.06***	0.76	0.06***
	SD	0.01	0.30	0.01	0.38	0.01	0.33
Trace QR	Mean	1.01	0.07***	0.38	0.10***	0.82	0.08***
	SD	1.04	0.21***	0.98	0.22***	1.02	0.21***
Ethnogroup*Trace QR				0.59	0.10***	0.56	0.11***
Scanning*Trace QR				0.57	0.10***		
Reading time*Trace QR						0.00	0.00
Goodness of fit							
AIC		9,364		9,311		9,344	
BIC		9,430		9,391		9,424	
Log-likelihood		−4,672		−4,643		−4,660	

Note(s): *** indicates a significance at 0.001
β is the coefficient, SE is the standard error, and SD is the standard deviation
Source(s): Authors' work

Table 5.
Choice data analysis results

	WTP (€)	SE	CI 95%	*p*-value
PDO	0.769	0.042	[0.687; 0.851]	***
Blockchain	0.264	0.030	[0.205; 0.323]	***
Company QR	0.562	0.043	[0.478; 0.646]	***
Trace QR	0.755	0.054	[0.649; 0.861]	***

Note(s): *** indicates a significance at 0.001. SE is the standard error and CI is the confidence interval
[a] Marginal willingness to pay of attribute $x = \frac{-\beta_x}{\beta_{Price}}$
Source(s): Authors' work

Table 6.
Marginal willingness to pay (WTP) for the examined attributes (based on Model 1)[a]

Geographical Indication (PGI) labelling is relatively high in Greece (Grunert and Aachmann, 2016).

Regarding the QR codes with traceability information, Greek consumers expressed a high valuation for this labelling scheme. Consumers' WTP for food traceability has been well-documented in the literature (See more the review of Vriezen *et al.*, 2023). In comparison, the absolute WTPs for the traceability QR code and PDO labels were nearly similar. However, besides providing only the locality and traditionality of the products, embedding traceability information in QR codes has more advantages than PDO labelling as it can help to convey more direct information to consumers such as information regarding antibiotic use (Bradford *et al.*, 2022), free of child labour (Lafargue *et al.*, 2022) and other sustainability claims (Bashir, 2022). Furthermore, consumers' awareness and knowledge of the certification schemes can be limited as proven in the case of PDO in several countries (Grunert and Aachmann, 2016). Hence, providing explicit information about the food products via a QR code can be considered as an alternative to efficiently communicate the advanced features of food products.

The positive valuation for the company QR suggests that companies can provide more information about their companies via a QR code to consumers, allowing consumers to know more about their company and their products, which may eventually lead to higher brand engagement and appreciation (Rotsios *et al.*, 2022).

The relatively low valuation for blockchain-indication labels could be due to the low consumers' familiarity with and knowledge of this novel technology in Greece as only 12% of the sample were familiar with this concept. This is also the case in several countries. For instance, Lin *et al.* (2022) found that Chinese consumers reported a relatively low subjective knowledge about blockchain traceability (mean = 5.38/9). Shew *et al.* (2021) found that American consumers know little about the application of blockchain technology and mostly associate blockchain applications with cryptocurrencies. Nevertheless, to the best of the authors' knowledge, this study is one of the first studies providing evidence of positive consumers' valuation of food blockchain-based traceability in Europe.

5.2.2 Effect of consumer ethnocentrism, scanning QR and time of reading extra information on consumers' valuations for Feta cheese attributes. The influence of consumer ethnocentrism on consumers' valuation of traceability information embedded in QR codes was examined using the interaction term *Ethnogroup*Trace QR* (Table 6). The significant positive values of *Ethnogroup*Trace QR* in both Model 2 and 3 indicated that highly ethnocentric consumers tended to appreciate a QR code with traceability information of Feta cheese, which confirmed Hypothesis 1.

In Model 2, the coefficient of *Scanning*Trace QR* was significantly positive implying that consumers who scanned the QR code were also more likely to prefer a traceability QR code, which confirmed Hypothesis 2. However, in Model 3, the coefficient of *Reading time*Trace QR* was insignificant indicating that time spent reading the QR-embedded information did not affect the valuation of the traceability information embedded in QR codes. This finding rejected Hypothesis 3. Besides, the goodness-of-fit indicators of Model 2 (AIC = 9,344, BIC = 9,424, Log-likelihood = −4,660) were better than those of Model 3 (AIC = 9,311, BIC = 9,391, Log-likelihood = −4,643) suggesting that the interaction of *Scanning*Trace QR* explained the preference heterogeneity of consumers' valuation of traceability information better than that of *Reading time*Trace QR*.

As proven in our models, consumers who read the traceability information embedded in QR codes also displayed a higher valuation for products that contained traceability information. However, the causality of this result should be interpreted with caution. One argument could be that only consumers who were already interested in traceability information would choose to scan a QR code to read this information, whilst others might argue that scanning a QR code provides information that subsequently enhances consumers' knowledge and appreciation of traceable products. Recent findings by Rotsios *et al.* (2022) support the latter argument, as they discovered that scanning a QR code on food packaging to access a company website increased overall product understanding and intention to use the product.

5.3 Limitations

This study also has some limitations. First, data collection was conducted in Greece, focussing on Feta cheese to facilitate the investigation of the relationship between consumer ethnocentrism and consumers' valuation of food traceability. However, due to the specific context of the country and the product of interest, the generalisation of the findings of this study should be treated with caution. Future studies may evaluate the influence of consumer ethnocentrism and traceability information in other countries and regions or a cross-country context for a wider range of products. Second, this study observed the intention to scan a QR code with traceability information via an online survey not in a store setting. Scholars can

conduct observational experiments in real stores to investigate consumers' scanning behaviour and its relation to consumer ethnocentrism level in the future.

6. Conclusion

This study provides empirical evidence of a positive WTP for blockchain-based traceability food products in the context of Feta cheese in Greece. Particularly, ethnocentric consumers were found to be more likely to scan traceability QR codes to obtain more product information and this consumer segment also had a higher WTP for traceable foods. Therefore, patriotic marketing messages could be useful to attract consumers to traceability information. This study also found that a higher intention to scan traceability QR codes was associated with a higher WTP for traceable QR codes, but spending more time reading QR-embedded information did not lead to the same result. This emphasises the need for concise marketing communication even with the detailed information provided via QR codes. Since QR codes indicating company information generate a lower WTP than traceability QR codes, food companies are recommended to indicate the main content of QR codes with traceability information on food packaging so that consumers can distinguish such traceability codes from other codes with general information.

6.1 Scientific contributions and future research recommendations

To the best of the authors' knowledge, this study is the first to investigate the impact of consumer ethnocentrism on the valuation of food traceability. In this study, food traceability was defined as information about specific breeders that provide raw materials and time stamps for production steps. Such a high level of granularity of traceability information may not be communicated to consumers in other use cases. For instance, the study of Wu *et al.* (2017) measured traceability information with different levels namely traceability to the processing facility and traceability to the farm level and then found that the more detailed traceability resulted in a higher WTP. In a similar vein, future studies can examine the extent to which consumer ethnocentrism influences the valuation for different traceability levels as ethnocentric consumers may only be interested in detailed traceability information.

This study found that scanning QR codes could increase the WTP for traceable foods. This finding extends the literature regarding consumers' valuation of QR codes on food packaging as a marketing strategy such as the use of QR codes for gamification (Violino *et al.*, 2019) or informational provisions related to sustainability practises (Bashir, 2022). In this regard, it is of interest to compare consumers' valuation of different content of QR codes and to examine whether different embedded information in QR codes would lead to different likelihood of scanning such codes.

This study found a high WTP for PDO and QR codes with traceability information as two discrete attributes. However, as it becomes increasingly common to communicate food product traits via QR codes (Kim and Woo, 2016), some certifications such as organic (Shew *et al.*, 2021) and Fairtrade (Balzarova *et al.*, 2022) have been suggested to consider using traceability QR codes to transparently communicate their practises to consumers. Therefore, it is of interest to investigate the combined effect and interaction of traceability information and certification labelling on consumers' valuation of food products in future studies.

This study has shown that consumers were inclined to pay more for traceable food after reading traceability information. However, traceability information can be complex and not all the information is relevant or of interest to consumers (Qian *et al.*, 2017). In this study, the traceability information page (See Supplementary Material) also included a variety of information for consumers, ranging from the exact locations of breeders to time stamps of production steps. Given the limited time consumers spend reading QR-embedded

information, it is crucial to identify which type of information captures more consumer attention. Future studies can employ eye-tracking or virtual reality (VR) methods to identify consumers' visual attention to certain information on a traceability information page, which helps companies focus their efforts on providing more relevant information to consumers.

6.2 Practical implications

Since the traceability systems of processed food products (e.g. cheese and cereal flour) are more complex than those of unprocessed products due to the mixing of multiple raw material sources during production (Qian *et al.*, 2017; Gésan-Guiziou *et al.*. 2022), recent blockchain-based traceability projects have mostly focussed on primary products such as beef and fruit (Latino *et al.*, 2022). Given the limited number of blockchain-based traceability systems for processed food products, this study is one of the first to empirically prove that consumers are willing to pay a price premium for Feta cheese with blockchain-based traceability information. This finding could encourage food companies to invest in more advanced traceability systems to meet the increasing demand for traceable food products (Vriezen *et al.*, 2023). Besides, the elicited WTP in this study can serve as a benchmark for practitioners to translate the recorded traceability information into monetary benefits.

As consumer ethnocentrism could positively affect the valuation for traceability information and motivate consumers to scan traceability QR codes, patriotic marketing messages may be effective in attracting ethnocentric consumers to the provided traceability information and subsequently lead to a higher WTP for traceable products.

The positive effect of scanning QR codes with traceability information on consumers' valuation of traceable foods may vary due to various factors. Latino *et al.* (2022) pointed out in their organic olive oil case study in Italy that there were two critical factors to effective communication of traceability information, namely selecting relevant information to consumers' interest and making such information comprehensible by using data visualisation and a user-friendly platform. Regarding the former factor, Kim and Woo (2016) indicated that if consumers perceived that the information pertained to the QR code as useful for making purchase decisions, they would be more likely to scan the QR code. Meanwhile, our study demonstrated that a longer reading time was not significantly associated with a higher valuation of traceable food products. However, Yang *et al.* (2022) reported that lack of time is one of the main reasons for not scanning a QR code at the point of sale. Hence, even though the main objective of having QR codes is to provide more information to consumers, such additional information should be presented concisely and understandably to take less time for consumers to comprehend.

The QR code with company information generated a lower price premium than the code with traceability information. However, without an indication of the content of the QR codes on the food packaging, consumers cannot distinguish between these two types of QR codes. Therefore, producers who aim to use QR codes to communicate traceability information need to ensure that consumers recognise the main content of the QR codes to motivate them to scan such codes.

Even though blockchain can potentially increase the efficiency and transparency of food traceability systems (Collart and Canales, 2021; Astill *et al.*, 2019), food chain actors may still be reluctant to invest in blockchain-based systems if these systems do not bring sufficient economic benefits to justify the costs and efforts of implementing them. As the cost of implementing blockchain-based systems is more likely to be passed on to consumers, it is essential to ensure that consumers are willing to pay for such advanced traceability systems. This study found modest consumers' WTP for blockchain labels. This low WTP could be because blockchain is a novel technology that most consumers are not familiar with (Shew *et al.*, 2021; Lin *et al.*, 2022). Therefore, food companies that intend to adopt blockchain-based

systems are recommended to also make efforts to educate consumers about the benefits of blockchain technology so that consumers value and pay more for their blockchain-based traceable products.

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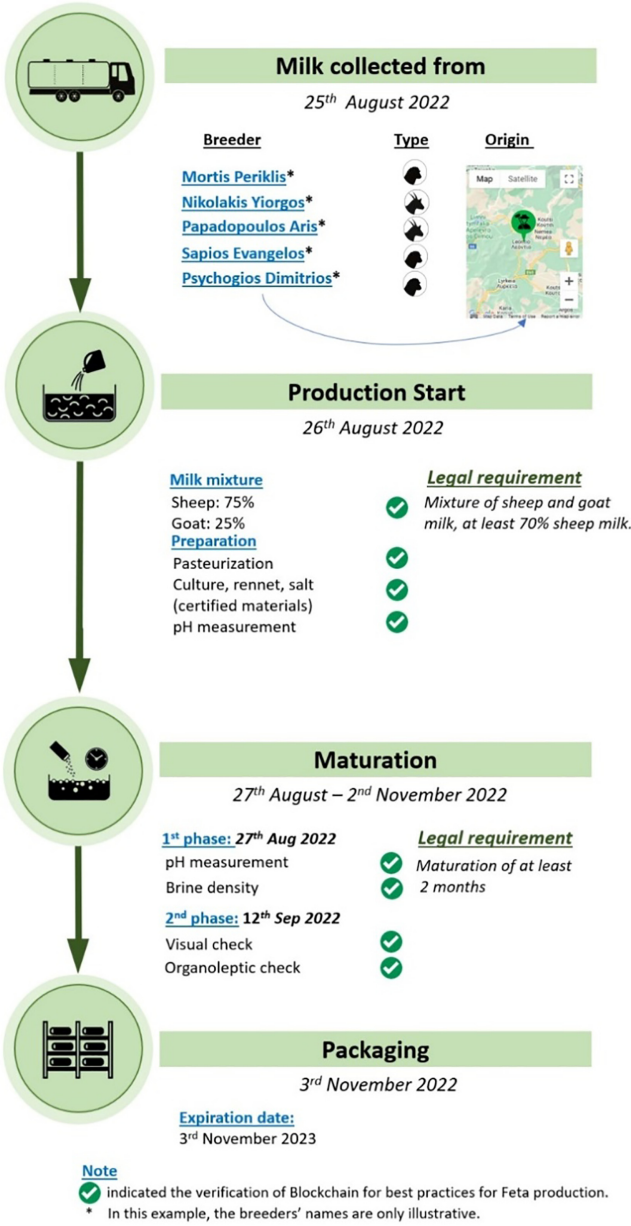
Supplementary material

Table S1. Socio-demographic characteristics of the sample (n = 715)

	Mean/Categories	Percentage (%)
Age	41.56	
	18–25 years old	10.07
	25–35 years old	17.48
	35–45 years old	31.75
	45–55 years old	25.73
	55–65 years old	14.41
	>65 years old	0.56
Gender		
	Male	29.23
	Female	70.77
Income		
	Below €500	18.04
	From €501 to €1,000	41.26
	From €1,001 to €1,500	28.53
	From €1,501 to €2,000	8.39
	Above €2,000	3.64
Highest education level		
	Highschool or below	23.92
	Undergraduate	54.97
	Postgraduate or above	20.98
Responsibility for buying food		
	(Partially) Yes	98.88
	No	1.12
Residency		
	Urban area (city)	91.19
	Rural area (suburban. village)	8.81
*Frequency of buying Feta cheese**		
	Less than 1 time per month	13.15
	Less than 4 times per month	25.31
	Every week	61.26
Familiar with scanning QR codes		71.05
Familiar with blockchain technology to ensure food traceability authenticity		12.31

Note(s): *Respondents who never buy Feta cheese are excluded from the dataset
Source(s): Authors' work



Source(s): Authors' work

Figure S1.
Additional information embedded in a QR code