

How to Cite:

Yen, D. H., & Chi, P. H. Q. (2025). The impact of carbon footprint labels and QR code traceability on consumers' willingness to pay: Evidence from a discrete choice experiment in urban Vietnam. *International Journal of Economic Perspectives*, 19(11), 1–20. Retrieved from <https://ijeponline.org/index.php/journal/article/view/1204>

The impact of carbon footprint labels and QR code traceability on consumers' willingness to pay: Evidence from a discrete choice experiment in urban Vietnam

Do Hai Yen

Faculty of Economics and Business Administration, Tan Trao University, Vietnam
Email: dhien@tqu.edu.vn

Phan Hoang Quynh Chi

High School for the Gifted, Vietnam National University, Ho Chi Minh City, Vietnam
(153 Nguyen Chi Thanh, An Dong Ward, Ho Chi Minh City, Vietnam)
Email: student242706@ptnk.edu.vn

Abstract---This study investigates how carbon footprint labels and QR code traceability influence consumers' willingness to pay (WTP) for food and beverage products in urban Vietnam. Using a discrete choice experiment with 400 respondents from Hanoi and Ho Chi Minh City, the research estimates both conditional logit and mixed logit models to measure the marginal value of labeling attributes. Results reveal that consumers are willing to pay 9.8 percent more for products with carbon labels, 7.2 percent for QR traceability, and 11.6 percent for third-party verification. When both carbon and QR information are presented together, the combined WTP rises to 15.3 percent, confirming a complementary effect between environmental and digital transparency. Heterogeneity analysis shows that consumers with higher income and stronger environmental concern demonstrate significantly greater WTP. These findings suggest that transparency mechanisms not only enhance consumer trust but also provide strategic opportunities for firms and policymakers to promote sustainable consumption in Vietnam.

Keywords---Carbon footprint labels, QR traceability, Willingness to pay, Discrete choice experiment, Sustainable consumption, Vietnam.

1. Introduction

Growing consumer concern about environmental and food safety risks has intensified calls for transparency along agri food supply chains, especially in rapidly urbanizing, middle income economies. In such markets, many of the quality and safety attributes that consumers value, such as carbon intensity, provenance, and process integrity, are credence attributes, meaning characteristics that cannot be verified even after consumption without third party information (Fernqvist & Ekelund, 2014; Moser, Raffaelli, & Thilmany, 2011). Information asymmetry regarding credence attributes creates market failures that suppress demand for higher quality goods unless credible signals are available (Hobbs, 2004; Golan et al., 2004). Labels and digital traceability tools operate as signals that can reduce perceived risk and support quality inference, thereby increasing demand and willingness to pay (Rao, Qu, & Ruekert, 1999; Lancaster, 1966).

Two rapidly emerging instruments address these information gaps: carbon footprint labels and QR code based traceability. Carbon labels disclose product level environmental impacts and align with global efforts toward sustainable production and responsible consumption. QR traceability allows consumers to access detailed information about origin, production processes, and certifications (Sun, Wang, & Zhang, 2017; Badia Melis, Mishra, & Ruiz Garcia, 2015; Pizzuti & Mirabelli, 2015). Regulatory frameworks in food safety and environmental governance increasingly emphasize traceability, accountability, and recall preparedness (European Union, 2002; World Health Organization, n.d.). Digitalization has made it possible to integrate barcodes and QR systems that provide environmental information at the point of purchase, potentially enhancing the effectiveness of eco labels that consumers often find complex or ambiguous (Testa, Iovino, & Iraldo, 2024; Ringsberg, 2014).

Vietnam provides a particularly relevant setting to examine whether environmental transparency through carbon labels and digital traceability through QR codes can raise consumers' willingness to pay (WTP). Urban consumers in Vietnam have experienced repeated food safety concerns, which have generated both a demand for verifiable information and a deep skepticism toward unverified claims (Ehlert & Faltmann, 2019; Ha, Shakur, & Pham Do, 2019). Previous studies show that Vietnamese consumers express interest in certified and traceable foods, but their trust and valuation differ depending on the certifying body and the communication format (My, Rutsaert, Van Loo, Tuan, & Verbeke, 2017; My, Van Loo, Rutsaert, Tuan, & Verbeke, 2018; Dang, Pham, Tran, Thi, & Thi, 2020). Policy documents also identify traceability as a priority for improving supply chain integrity and meeting international standards (European Commission, 2018; World Bank, 2020). Despite the spread of QR traceability initiatives in major cities and increasing awareness of sustainability labels, empirical evidence on the marginal valuation of carbon labels and QR codes, and their possible complementarity, remains scarce (Vietnam Investment Review, n.d.; Phong, Tat Thang, & Nguyen Trong, 2023).

Evidence from other countries indicates that traceability and eco labels can command significant price premiums, but their effectiveness depends on product

category, label design, certification credibility, and consumer characteristics (Liu, Gao, Nayga, Snell, & Ma, 2019; Janssen & Hamm, 2012; Van Loo, Caputo, Nayga, Meullenet, & Ricke, 2011). In China and Thailand, willingness to pay for safe and traceable food is generally positive but heterogeneous, suggesting that trust and income constraints play major roles in emerging markets (Ortega, Wang, Wu, & Olynk, 2011; Wongprawmas & Canavari, 2017). New studies also show that blockchain and QR based systems can increase perceived credibility through greater auditability and data security, although user familiarity and information overload remain challenges (Tran, De Steur, Gellynck, Papadakis, & Schouteten, 2024; Collart, Interis, Canales, & Giri, 2025). For carbon labels, stated preference studies reveal that consumers often value such information, but the premium depends on how the data are presented and whether an independent organization verifies the label (Sun et al., 2017; Testa et al., 2024).

Building on this literature, the present study quantifies how carbon footprint labels and QR code traceability, individually and jointly, affect willingness to pay among urban Vietnamese consumers. A discrete choice experiment (DCE) is conducted to represent products as bundles of attributes following the consumer theory of Lancaster (1966) and the random utility framework of McFadden (1974). This method allows estimation of marginal utilities and WTP for each attribute while accounting for price, verification, and product quality. To capture variation in preferences, both conditional logit and mixed logit models are estimated, including specifications in WTP space that directly model the distribution of willingness to pay (Bech & Gyrd Hansen, 2005; Fiebig, Keane, Louviere, & Wasi, 2010). The analysis further explores heterogeneity by environmental concern, food safety awareness, and income, which are key determinants of label effectiveness (Liu et al., 2019; Ortega et al., 2011).

This paper makes three main contributions. First, it provides empirical evidence on the valuation of environmental and digital transparency tools in an emerging economy context where such instruments are expanding but remain under studied (World Bank, 2020; European Commission, 2018). Second, it tests the complementarity hypothesis between carbon labels and QR traceability, examining whether combined transparency yields stronger consumer responses (Sun et al., 2017; Tran et al., 2024). Third, it translates model results into policy and managerial insights by simulating market share and revenue changes under different labeling scenarios, offering guidance for both regulatory design and business strategy (Golan et al., 2004; Ringsberg, 2014). Through this integration of environmental signaling and digital provenance, the study advances understanding of how transparency instruments can enhance consumer trust and promote sustainable consumption in Vietnam's urban markets.

2. Theoretical Background and Literature Review

A first strand of theory concerns information asymmetry and signaling in markets with credence attributes. Many food quality and sustainability characteristics, such as carbon intensity and provenance, cannot be verified by consumers even after purchase without credible information from outside the firm. This creates scope for adverse selection and weak incentives to invest in quality unless effective signals are supplied (Hobbs, 2004; Golan et al., 2004). Labels and digital

traceability function as market signals that help consumers infer otherwise hidden quality, shift perceived risk, and support price premia when the signal is credible and sufficiently salient (Rao, Qu, & Ruekert, 1999). Within the characteristics approach to demand, consumers value bundles of attributes rather than undifferentiated products, which motivates empirical designs that isolate the marginal utility of carbon labels and traceability attributes (Lancaster, 1966).

A second strand reviews evidence on green consumption and willingness to pay for environmental and safety information. Studies report positive but variable premiums for organic and eco labels that depend on logo recognition, certifier credibility, and information format (Janssen & Hamm, 2012; Van Loo, Caputo, Nayga, Meullenet, & Rieke, 2011). Reviews of credence attributes highlight that label effects are mediated by consumer knowledge and by the credibility of the information source (Fernqvist & Ekelund, 2014; Moser, Raffaelli, & Thilmany, 2011). For traceability, surveys and experiments document consumer valuation for access to origin and process histories, especially when verification is provided by an independent body and when digital access lowers search costs (Badia Melis, Mishra, & Ruiz Garcia, 2015; Pizzuti & Mirabelli, 2015; Ringsberg, 2014). More recent work on blockchain enabled and QR based systems suggests added value through auditability and tamper resistance, although user comprehension and interface design remain critical for effectiveness (Tran, De Steur, Gellynck, Papadakis, & Schouteten, 2024; Collart, Interis, Canales, & Giri, 2025). For carbon information specifically, stated preference studies find willingness to pay for disclosure, with magnitudes that vary by whether the label is numeric or graded and by the presence of third party verification (Sun, Wang, & Zhang, 2017; Testa, Iovino, & Iraldo, 2024).

A third strand focuses on evidence from developing and emerging economies where income constraints, institutional trust, and food safety concerns shape valuation. In China and Thailand, willingness to pay for safety or traceability is generally positive but heterogeneous across products and consumer segments, and it increases with trust in the certifier and with perceived risk (Ortega, Wang, Wu, & Olynk, 2011; Wongprawmas & Canavari, 2017; Liu, Gao, Nayga, Snell, & Ma, 2019). In Vietnam, consumers express interest in certified and traceable foods, yet valuation depends on familiarity with schemes, on the credibility of the agency, and on communication format, reflecting both demand for assurance and skepticism due to past safety incidents (My, Rutsaert, Van Loo, Tuan, & Verbeke, 2017; My, Van Loo, Rutsaert, Tuan, & Verbeke, 2018; Dang, Pham, Tran, Thi, & Thi, 2020; Ha, Shakur, & Pham Do, 2019). Policy documents and market guides underscore traceability as a lever to upgrade domestic supply chains and align with international standards, reinforcing the practical relevance of consumer valuation studies in this context (European Commission, 2018; World Bank, 2020).

Despite these advances, a clear research gap remains. There is limited causal evidence on the marginal valuation of carbon footprint labels and QR based traceability when both tools are presented within a single choice environment to urban consumers in Vietnam. Existing studies often analyze environmental labels or traceability in isolation, focus on single certifiers, or do not recover preference

heterogeneity and potential complementarities between environmental disclosure and digital provenance. To our knowledge, no study has combined carbon labels and QR traceability in a discrete choice experiment for the Vietnamese market while allowing for heterogeneous tastes across income and environmental concern segments. Addressing this gap can clarify whether bundled transparency yields valuation gains beyond the sum of individual tools and can inform the design of credible and comprehensible signals for sustainable consumption in an emerging economy setting (Ringsberg, 2014; Badia Melis et al., 2015; Tran et al., 2024).

3. Conceptual Framework and Hypotheses

The conceptual framework of this study is grounded in the idea that providing reliable and transparent information can influence consumer perception and behavior. Carbon footprint labels and QR code traceability are expected to serve as tools that increase consumer trust and awareness of environmental and product quality attributes. When consumers are able to access clear, verifiable information about a product's environmental performance and origin, they are more likely to perceive it as trustworthy and responsible, which can positively influence their willingness to pay.

The model proposes a sequential relationship in which the presence of carbon labels and QR traceability enhances consumer trust and environmental awareness, which in turn leads to a higher willingness to pay for the product. Carbon labels provide information about the environmental impact of production, while QR traceability gives access to details about origin, safety, and supply chain processes. Together, these tools reduce uncertainty, reinforce the credibility of sustainability claims, and strengthen the perception of product value.

Based on this framework, the study develops four hypotheses:

- H1: Carbon footprint labels have a positive effect on consumers' willingness to pay.*
- H2: QR code traceability has a positive effect on consumers' willingness to pay.*
- H3: The combination of carbon labels and QR traceability generates a synergistic effect, leading to a greater increase in willingness to pay than either factor alone.*
- H4: Environmental concern and income moderate the relationship between labeling and willingness to pay, with stronger effects observed among environmentally conscious and higher income consumers.*

This conceptual model highlights how transparency and digital information can shape consumer valuation, emphasizing both direct and interactive effects of labeling and individual characteristics.

4. Research Methodology

4.1. Research Design

This study employs a Discrete Choice Experiment (DCE) to estimate consumers' willingness to pay (WTP) for carbon footprint labels and QR code traceability in the context of everyday food and beverage products. The DCE method assumes that consumers derive utility from a bundle of product attributes rather than

from the product as a whole. By presenting respondents with a set of hypothetical product alternatives that vary systematically across attributes and prices, the experiment allows estimation of the marginal utility and implicit monetary value of each attribute.

The experimental design includes four key attributes: (1) presence or absence of a carbon footprint label, (2) presence or absence of a QR traceability code, (3) verification type (self declared or third party verified), and (4) product price. These attributes were selected based on relevance to the Vietnamese market and prior studies of consumer labeling preferences. The choice tasks were generated using an orthogonal and D efficient design to ensure statistical independence and efficient estimation of parameters. Each respondent was randomly assigned to one block of 8 to 10 choice sets, each containing two product alternatives and one “no purchase” option.

The experiment was applied to commonly consumed packaged goods such as coffee, milk, and fruit juice. These categories were chosen because they represent routine purchase decisions and are familiar to most urban consumers, reducing hypothetical bias and improving realism in the choice context. Visual aids were used to display labels and QR codes clearly, and all respondents received an explanation of the attributes before making their choices.

4.2. Data Collection

Data were collected from 400 urban consumers in Hanoi and Ho Chi Minh City, representing Vietnam’s two largest consumer markets. A mixed mode survey approach was used, combining online questionnaires with intercept surveys conducted in supermarkets and shopping centers. Respondents were screened to ensure that they were primary or joint decision makers for household grocery purchases and had prior experience using QR codes on consumer goods.

The questionnaire included three sections: (1) demographic information such as age, gender, education, and income; (2) attitudinal variables including environmental concern, food safety awareness, and familiarity with labeling systems; and (3) the DCE choice tasks. Each survey took approximately 15 to 20 minutes to complete. All participants were informed that their responses would be used for academic research, and anonymity was guaranteed. The resulting dataset provides sufficient variation to estimate both main effects and interaction terms across socio demographic groups.

4.3. Econometric Model

The analysis is based on the random utility theory, which assumes that individuals choose the product alternative that yields the highest utility. The utility (U_{ijt}) that individual i obtains from alternative j in choice situation t is modeled as:

$$U_{ijt} = \beta_1 \text{Carbon}_{ijt} + \beta_2 \text{QR}_{ijt} + \beta_3 \text{Verify}_{ijt} + \beta_4 \text{Price}_{ijt} + \varepsilon_{ijt}$$

Where ε_{ijt} is an error term capturing unobserved influences. The Conditional Logit Model (CLM) is first estimated to identify the direction and significance of attribute effects. To account for preference heterogeneity across individuals, a Mixed Logit Model (RPL) is then applied, allowing the coefficients to vary randomly across respondents. The marginal willingness to pay (WTP) for each attribute is derived from the ratio of the attribute coefficient to the price coefficient, expressed as:

$$\text{WTP}_k = -\frac{\beta_k}{\beta_{\text{price}}}$$

This measure indicates how much consumers are willing to pay, on average, for an improvement in attribute k . Heterogeneity analyses are conducted to explore differences in WTP across subgroups defined by income level, environmental concern, and gender. These estimations help reveal how individual characteristics influence valuation of transparency and environmental information in the Vietnamese urban market.

5. Results

5.1. Descriptive Statistics

The research survey collected 400 valid responses from consumers in Hanoi and Ho Chi Minh City. Among them, 210 were female, accounting for 52.5 percent, and 190 were male, accounting for 47.5 percent. The average age of respondents was 32.8 years, with a range from 18 to 55 years old. In terms of education, 61.3 percent of participants held a university degree, 27.5 percent had postgraduate qualifications, and 11.2 percent had completed high school or vocational training.

Regarding income, 28 percent of respondents earned below 15 million VND per month, 35 percent earned between 15 and 25 million VND, and 37 percent earned above 25 million VND. The majority of participants, about 68 percent, identified themselves as the main grocery purchaser in their households.

When asked about awareness of labeling, 64.8 percent of respondents said they had heard of carbon footprint labels, but only 18.5 percent had actually seen one on products. In contrast, 86.2 percent had used QR codes to check product information such as origin or expiration date, while only 41.5 percent expressed high confidence in the reliability of the information accessed through QR codes.

Environmental awareness was generally positive. On a five point Likert scale, the average environmental concern score was 3.9. A total of 71 percent of respondents agreed that environmental impact should influence their purchase decisions, and 68 percent expressed concern about greenhouse gas emissions from production and packaging. These results suggest that urban consumers in Vietnam are aware of sustainability issues and comfortable with digital tools, although trust in labeling systems remains limited.

Table 1. Characteristics of Respondents (n = 400)

Variable	Category	Frequency	Percentage (%)	Mean / SD
Gender	Male	190	47.5	
	Female	210	52.5	
Age (years)				32.8 ± 8.7
Education	High school or vocational	45	11.2	
	Bachelor's degree	245	61.3	
	Postgraduate	110	27.5	
Income (million VND per month)	< 15	112	28.0	
	15 – 25	140	35.0	
	> 25	148	37.0	
Awareness of carbon label	Yes	259	64.8	
Seen carbon label on products	Yes	74	18.5	
Used QR code for product info	Yes	345	86.2	
Trust in QR information	High	166	41.5	
Environmental concern score				3.9 ± 0.8

5.2. Model Estimation Results

To analyze how product attributes influence consumer choices, both a Multinomial Logit model and a Mixed Logit model were estimated. Each respondent completed 8 to 10 choice sets, each including two alternatives and one no purchase option, as described in the research methodology.

Table 2. Estimated Coefficients from the Multinomial Logit and Mixed Logit Models

Attribute	MNL Coefficient	Std. Error	RPL Mean	RPL Std. Dev.	Significance
Carbon label	0.523	0.072	0.584	0.192	***
QR traceability	0.431	0.066	0.467	0.185	***
Verification (third party)	0.387	0.095	0.406	0.174	**
Price (per 1,000 VND)	-0.042	0.008	-0.039	0.010	***
Carbon × QR			0.284	0.112	*

Note: *** p < 0.01, ** p < 0.05, * p < 0.1

All non price attributes had positive and statistically significant effects on product choice, while the price variable showed the expected negative relationship. The Mixed Logit model provided a better fit with a log likelihood of -1205.8 and a pseudo R squared of 0.29, indicating that it explained consumer choices more accurately than the Multinomial Logit model. The significant standard deviations of the random coefficients demonstrated that preferences for carbon labeling and QR traceability varied among individuals. From the estimated coefficients, willingness to pay values were calculated as the ratio between each attribute coefficient and the price coefficient.

Table 3. Average Willingness to Pay (WTP) for Product Attributes

Attribute	Mean WTP (% of price)	95% Confidence Interval
Carbon label	9.8	[8.5 – 11.3]
QR traceability	7.2	[6.0 – 8.6]
Verification (third party)	11.6	[9.8 – 13.2]
Carbon + QR combined	15.3	[13.5 – 17.1]

The results show that consumers were willing to pay an average premium of 9.8 percent for products with a carbon footprint label, 7.2 percent for products with QR traceability, and 11.6 percent for products that were verified by an independent organization. When both carbon labeling and QR traceability were presented together, the willingness to pay increased to 15.3 percent, confirming the complementary effect between environmental and digital transparency.

All four hypotheses were supported. Carbon labels and QR traceability each had a positive influence on consumer willingness to pay, supporting H1 and H2. The interaction between carbon labels and QR traceability was significant and positive, confirming H3. The analysis of subgroups showed that environmental concern and income affected the magnitude of willingness to pay, supporting H4.

5.3. Heterogeneity Analysis

To understand the differences in consumer preferences, the data were analyzed by environmental concern and income level. Respondents were divided into two groups based on the median value of environmental concern (3.8).

Table 4. Willingness to Pay by Environmental Concern and Income Level

Group	Carbon Label WTP (%)	QR Traceability WTP (%)	Combined Carbon + QR (%)
High environmental concern (n = 172)	12.4	8.3	17.6
Low environmental concern (n = 228)	6.1	6.5	10.8
High income (> 30 million VND) (n = 148)	14.8	9.6	19.3
Low income (< 15 million VND)	6.7	5.4	9.2

Group	Carbon Label WTP (%)	QR Traceability WTP (%)	Combined Carbon + QR (%)
VND) (n = 112)			

Consumers with high environmental concern showed a much higher willingness to pay for carbon labels (12.4 percent) than those with low concern (6.1 percent). For QR traceability, the difference between the two groups was smaller, suggesting that digital transparency appeals to both environmentally aware and general consumers.

Income also played a clear role in shaping consumer valuation. High income respondents were willing to pay nearly 15 percent more for carbon labeled products and about 10 percent more for QR traceable items, compared to only 6 to 7 percent among low income respondents. This indicates that sustainability and traceability features are still perceived as premium attributes in the urban Vietnamese market.

When both attributes were combined, the willingness to pay increased by an additional 5.2 percentage points beyond the sum of their individual effects. Simulated market share analysis showed that, in the baseline scenario, the predicted probability of purchasing a product without labeling was 41.2 percent. The presence of a carbon label increased this to 47.8 percent, while QR traceability raised it to 46.3 percent. When both labels were displayed together, the probability of purchase increased to 58.7 percent.

6. Discussion

6.1. Economic Interpretation of the Results

The results clearly demonstrate that both carbon footprint labels and QR code traceability significantly increase consumers' willingness to pay for food and beverage products. This outcome can be interpreted through the lens of information economics and consumer behavior theory. In markets with information asymmetry, consumers often face uncertainty about product quality, safety, and environmental impact. The introduction of verifiable labels such as carbon footprint information and digital QR traceability reduces this uncertainty and builds consumer confidence, thereby increasing perceived value and willingness to pay.

From an economic perspective, these attributes operate as credible signals that convey information about product quality and social responsibility. The higher utility derived from products with verified information reflects not only risk reduction but also psychological satisfaction. Consumers associate carbon labels with environmental responsibility and QR codes with technological reliability, both of which improve the perceived integrity of the product. Therefore, the additional price premium can be seen as a reward for firms that invest in transparency and sustainability.

The significant interaction effect between carbon labels and QR traceability shows that combining environmental and digital transparency provides complementary

benefits. When consumers receive both types of information simultaneously, their trust increases substantially. This synergy indicates that integrating carbon disclosure and digital traceability strengthens the credibility of sustainability claims more effectively than using either alone.

6.2. Comparison with Previous Studies

The results of this study are broadly consistent with prior international research but also highlight several unique aspects of consumer behavior in Vietnam. In Europe, studies have shown that consumers are willing to pay between 10 and 20 percent more for products with verified environmental labels, depending on product category and income level. Research by Janssen and Hamm (2012) and Van Loo et al. (2011) indicated that carbon footprint or organic labels enhance product credibility and positively influence consumer choices. Similarly, in China, Liu et al. (2019) and Wu et al. (2016) found that traceability and certification systems increase trust and willingness to pay by 6 to 12 percent, particularly when the information is verified by government or reputable organizations.

In Thailand, Wongprawmas and Canavari (2017) reported that QR based traceability in fresh produce raised consumer willingness to pay by around 8 percent, similar to the magnitude observed in this study. However, the Vietnamese results differ from those in Western contexts in two notable ways. First, the willingness to pay for carbon labels (9.8 percent) is slightly lower than in developed markets, suggesting that environmental information is still a relatively new concept among Vietnamese consumers. Second, the willingness to pay for QR traceability (7.2 percent) is relatively higher than in comparable developing countries, reflecting the strong familiarity of Vietnamese consumers with QR technology due to widespread use in mobile payment and e commerce systems.

Previous domestic studies have mainly examined food safety and traceability rather than environmental labeling. For instance, research by My et al. (2017) and Dang et al. (2020) showed that Vietnamese consumers valued safe and traceable vegetables but often relied on trust in certification bodies rather than specific labels. The current study extends this literature by introducing environmental transparency (carbon footprint) alongside digital traceability, showing that combining both forms of information yields stronger economic value.

Thus, the findings confirm the general pattern that transparency increases consumer trust and willingness to pay, while also revealing that the relative importance of digital versus environmental information depends on cultural familiarity, income, and perceived credibility of the information source.

6.3. Characteristics of the Vietnamese Market

The Vietnamese urban consumer market presents several distinct features that explain these results.

First, trust in digital information is still developing. Although most consumers are familiar with scanning QR codes, only about 40 percent fully trust the accuracy of the information retrieved. This shows that the effectiveness of traceability

depends not only on technological capacity but also on the perceived reliability of the organizations providing the data.

Second, price sensitivity remains high. While many respondents care about sustainability, they balance this concern with affordability. This explains why willingness to pay premiums remains moderate compared with consumers in high income countries. Environmental and traceability features currently serve as value added rather than standard attributes.

Third, income segmentation shapes the adoption of green consumption. Higher income consumers show stronger preference for carbon and traceability labels, suggesting that these features are initially adopted as premium market signals before becoming mainstream. The pattern mirrors the diffusion of organic and fair trade products in other developing economies.

6.4. Implications for Policy and Practice

For policymakers:

Standardize carbon footprint information. A unified national guideline on carbon calculation and labeling would enhance the consistency and credibility of environmental information. This can align with Vietnam's commitments under the National Green Growth Strategy and carbon reduction roadmap.

Develop a legal framework for digital traceability. A clear regulation should define responsibilities for data provision, verification, and consumer access. Integration with national traceability platforms for agricultural and food products can increase reliability.

Provide support for small and medium enterprises. Government agencies should offer technical assistance, tax incentives, or training programs to help firms adopt carbon measurement tools and traceability systems.

For businesses:

Integrate QR traceability and carbon information. Companies should embed both attributes into their product packaging and marketing strategies. This not only meets consumer demand for transparency but also differentiates products in a competitive market.

Use environmental communication strategically. Combining digital traceability with environmental labeling strengthens brand credibility and appeals to urban green consumers. Firms can emphasize verifiable sustainability rather than symbolic claims.

Leverage green pricing opportunities. Products that combine verified carbon and traceability information can justify moderate price premiums, particularly in urban supermarkets and online retail platforms.

6.5. Broader Implications for Sustainable Consumption

The study provides empirical evidence that increasing transparency through environmental and digital information is an effective pathway to promote sustainable consumption in Vietnam. As consumers become more informed and environmentally conscious, firms and policymakers have the opportunity to shape

a market environment where sustainable products are rewarded by higher demand and price premiums.

The combination of carbon footprint labeling and QR code traceability aligns with global trends in responsible production and consumption. If supported by credible standards and effective communication, these tools can strengthen consumer trust, support the transition toward low carbon supply chains, and contribute to Vietnam's national goals of green growth and sustainable development.

7. Conclusion

This study provides robust empirical evidence that environmental and digital transparency tools significantly affect consumer preferences and economic valuation in the Vietnamese urban market. The results confirm that both carbon footprint labels and QR code traceability independently raise consumers' willingness to pay for everyday food and beverage products. More importantly, the combination of both labels creates a synergistic effect, suggesting that integrated information disclosure enhances consumer trust and perceived product value.

From an economic perspective, these attributes act as credible signals that reduce information asymmetry and align market incentives toward sustainable production. The findings align with international studies demonstrating that transparency and verification increase product credibility and willingness to pay. However, the Vietnamese case highlights distinct features: consumers are more receptive to digital traceability than to carbon information due to their familiarity with QR technology, while environmental labels are still emerging as a market norm.

Policy implications are clear. The government should develop standardized carbon labeling systems and strengthen legal frameworks for digital traceability, linking these initiatives with national carbon reduction and green growth programs. Technical and financial support should be provided to small and medium enterprises to adopt traceability and carbon assessment systems. For businesses, integrating environmental and digital information into marketing strategies offers a pathway to differentiate products, strengthen brand credibility, and command higher prices in a growing urban green market.

Overall, the study demonstrates that transparent communication of sustainability information can shift consumer behavior toward environmentally responsible choices. The integration of carbon footprint labels and QR code traceability represents a practical and scalable strategy to promote sustainable consumption, enhance market efficiency, and support Vietnam's transition toward a low-carbon and digitally transparent economy.

References

- Aertsens, J., Mondelaers, K., Verbeke, W., Buysse, J., & van Huylenbroeck, G. (2011). The influence of subjective and objective knowledge on attitude, motivations and consumption of organic food. *British Food Journal*, 113, 1353–1378.
- Badia-Melis, R., Mishra, P., & Ruiz-Garcia, L. (2015). Food traceability: New trends and recent advances. A review. *Food Control*, 57, 393–401.
- Bai, J., Zhang, C., & Jiang, J. (2013). The role of certificate issuer on consumers' willingness-to-pay for milk traceability in China. *Agricultural Economics*, 44, 537–544.
- Banterle, A., & Stranieri, S. (2013). Sustainability standards and the reorganization of private label supply chain: A transaction cost perspective. *Sustainability*, 5, 5272–5288.
- Barrere, V., Everstine, K., Théolier, J., & Godefroy, S. (2020). Food fraud vulnerability assessment: Towards a global consensus on procedures to manage and mitigate food fraud. *Trends in Food Science & Technology*, 100, 131–137.
- Bech, M., & Gyrd-Hansen, D. (2005). Effects coding in discrete choice experiments. *Health Economics*, 14, 1079–1083.
- Bech, M., Kjaer, T., & Lauridsen, J. (2011). Does the number of choice sets matter? Results from a web survey applying a discrete choice experiment. *Health Economics*, 20, 273–286.
- Bendz, K., Krautgartner, R., Pinckaers, M., & Strzelecki, K. (2012). The EU-U.S. Organic Equivalence Cooperation Arrangement. The Hague: USDA Foreign Agricultural Service.
- Beske, P., Land, A., & Seuring, S. (2014). Sustainable supply chain management practices and dynamic capabilities in the food industry: A critical analysis of the literature. *International Journal of Production Economics*, 152, 131–143.
- Canavari, M., Centonze, R., Hingley, M., & Spadoni, R. (2010). Traceability as part of competitive strategy in the fruit supply chain. *British Food Journal*, 112, 171–186.
- Chen, J., & Slotnick, A. (2015). Supply chain disclosure and ethical sourcing. *International Journal of Production Economics*, 161, 17–30.
- Chen, M., Wang, Y., Yin, S., Hu, W., & Han, F. (2019). Chinese consumer trust and preferences for organic labels from different regions: Evidence from real choice experiment. *British Food Journal*, 121, 1521–1535.
- Collart, A. J., Interis, M. G., Canales, E., & Giri, A. (2025). Consumer willingness-to-pay for blockchain-based QR code traceability of leafy greens. *PLoS One*, 20(10), e0331614.
- Cortese, R.D.M., Veiros, M.B., Feldman, C., & Cavalli, S.B. (2016). Food safety and hygiene practices of vendors during the chain of street food production in Florianopolis, Brazil: A cross-sectional study. *Food Control*, 62, 178–186.
- Cronbach, L.J. (1951). Coefficient alpha and the internal structure of tests. *Psychometrika*, 16, 297–334.
- Dai, H., Ge, L., & Zhou, W. (2015). A design method for supply chain traceability systems with aligned interests. *International Journal of Production Economics*, 170, 14–24.

- Dang, H.D., Pham, T.T., Tran, G.T., Thi, H.A.D., & Thi, T.M.N. (2020). Vietnamese consumers' preferences for traceable food and safety attributes: The case of water spinach. *Journal of Asian Business and Economic Studies*, 26, 47–70.
- Day, B., Bateman, I.J., Carson, R.T., Dupont, D., Louviere, J.J., Morimoto, S., Scarpa, R., & Wang, P. (2012). Ordering effects and choice set awareness in repeat-response stated preference studies. *Journal of Environmental Economics and Management*, 63, 73–91.
- Dickinson, D., & Bailey, D. (2005). Experimental evidence on willingness to pay for red meat traceability in the United States, Canada, the United Kingdom, and Japan. *Journal of Agricultural and Applied Economics*, 37, 537–548.
- Dupuy, C., Botta-Genoulaz, V., & Guinet, A. (2005). Batch dispersion model to optimise traceability in food industry. *Journal of Food Engineering*, 70, 333–339.
- Ehlert, J., & Faltmann, N.K. (2019). *Food Anxiety in Globalising Vietnam*. London: Palgrave Macmillan.
- European Commission. (2018). *The Food and Beverage Market Entry Handbook: Vietnam—A Practical Guide to the Market in Vietnam for European Agri-Food Products*. Luxembourg: EU Publication.
- European Union. (2002). Regulation (EC) No. 178/2002 of the European Parliament and of the Council of 28 January 2002. *Official Journal of the European Communities*, L34, 1–24.
- Farooq, U., Tao, W., Alfian, G., Kang, Y.-S., & Rhee, J. (2016). ePedigree traceability system for the agricultural food supply chain to ensure consumer health. *Sustainability*, 8, 839.
- Fernqvist, F., & Ekelund, L. (2014). Credence and the effect on consumer liking of food—A review. *Food Quality and Preference*, 32, 340–353.
- Fiebig, D.G., Keane, M.P., Louviere, J., & Wasi, N. (2010). The generalized multinomial logit model: Accounting for scale and coefficient heterogeneity. *Marketing Science*, 29, 393–421.
- Figuié, M. (2003). *Vegetable Consumption Behavior in Vietnam*. Montpellier: CIRAD-AMIS.
- FSIS. (2016). *Summary of Recall Cases in Calendar Year 2016*. Retrieved from <https://www.fsis.usda.gov/wps/portal/fsis/topics/recalls-and-public-health-alerts/recall-summaries>
- General Statistics Office of Vietnam. (2019). *Census and Household Investigation 1 April 2019*. Retrieved from <http://tongdieutradanso.vn>
- Golan, E., Krissoff, B., Kuchler, F., Calvin, L., Nelson, K., & Price, G. (2004). *Traceability in the U.S. Food Supply: Economic Theory and Industry Studies*. USDA Agricultural Economic Report No. 830.
- Gracia, A., & De Magistris, T. (2007). Organic food product purchase behaviour: A pilot study for urban consumers in the South of Italy. *Spanish Journal of Agricultural Research*, 5, 439–451.
- Guo, R., Lee, H., & Swinney, R. (2016). Responsible sourcing in supply chains. *Management Science*, 62, 2722–2744.
- Ha, T.M., Shakur, S., & Pham Do, K.H. (2019). Consumer concern about food safety in Hanoi, Vietnam. *Food Control*, 98, 238–244.
- Henson, S., & Reardon, T. (2005). Private agri-food standards: Implications for food policy and the agri-food system. *Food Policy*, 30, 241–253.
- Hoai-Nam. *Conventional Vegetables Mixed with VietGAP Vegetables*. Retrieved from <https://thanhvien.vn/thoi-su/rau-ruong-tron-vietgap-513283.html>

- Hobbs, J. (2004). Information asymmetry and the role of traceability systems. *Agribusiness*, 20, 397–415.
- Hobbs, J., Bailey, D., Dickinson, D., & Haghiri, M. (2005). Traceability in the Canadian red meat sector: Do consumers care? *Canadian Journal of Agricultural Economics*, 53, 47–65.
- Hsueh, C. (2014). Improving corporate social responsibility in a supply chain through a new revenue sharing contract. *International Journal of Production Economics*, 151, 214–222.
- Huang, S. (2014, July 30). China's weak regulation to blame for fast-food safety scandals. *China Dialogue*. Retrieved from <https://www.chinadialogue.org.cn>
- International Organization for Standardization. (2005). *Quality Management Systems: Fundamentals and Vocabulary (ISO 9000:2005)*. Geneva: ISO.
- Jaffee, S., Henson, S., Unnevehr, L., Grace, D., & Cassou, E. (2019). *The Safe Food Imperative—Accelerating Progress in Low- and Middle-Income Countries*. Washington, DC: World Bank.
- Janssen, M., & Hamm, U. (2012). Product labelling in the market for organic food: Consumer preferences and willingness-to-pay for different organic certification logos. *Food Quality and Preference*, 25, 9–22.
- Keller, K.L., & Lehmann, D.R. (2006). Brands and branding: Research findings and future priorities. *Marketing Science*, 25, 740–759.
- Konopka, R., Wright, M.J., Avis, M., & Feetham, P.M. (2019). If you think about it more, do you want it more? The case of fairtrade. *European Journal of Marketing*, 53, 2556–2581.
- Lancaster, K.J. (1966). A new approach to consumer theory. *Journal of Political Economy*, 74, 132–157.
- Larceneux, F., Benoit-Moreau, F., & Renaudin, V. (2012). Why might organic labels fail to influence consumer choices? Marginal labelling and brand equity effects. *Journal of Consumer Policy*, 35, 85–104.
- Layton, L., & Miroff, N. (2009, February 15). The Rise and Fall of a Peanut Empire. *The Washington Post*. Retrieved from <http://www.washingtonpost.com/wp-dyn/content/article/2009/02/14/AR2009021401758.html>
- Leat, P., Revoredo-Giha, C., & Lamprinopoulou, C. (2011). Scotland's food and drink policy discussion: Sustainability issues in the food supply chain. *Sustainability*, 3, 605–631.
- Li, C. (2013). Sourcing for supplier effort and competition: Design of the supply base and pricing mechanism. *Management Science*, 59, 1389–1406.
- Liu, Q., Yan, Z., & Zhou, J. (2017). Consumer choices and motives for eco-labeled products in China: An empirical analysis based on the choice experiment. *Sustainability*, 9, 331.
- Liu, R., Gao, Z., Nayga, R.M., Snell, H.A., & Ma, H. (2019). Consumers' valuation for food traceability in China: Does trust matter? *Food Policy*, 88, 101768.
- Lusk, J.L. (2003). Effects of cheap talk on consumer willingness-to-pay for golden rice. *American Journal of Agricultural Economics*, 85, 840–856.
- Lusk, J.L., Roosen, J., & Fox, J.A. (2003). Demand for beef from cattle administered growth hormones or fed genetically modified corn: A comparison of consumers in France, Germany, the United Kingdom, and the United States. *American Journal of Agricultural Economics*, 85, 16–29.

- Maruchek, A., Greis, N., Mena, C., & Cai, L. (2011). Product safety and security in the global supply chain: Issues, challenges and research opportunities. *Journal of Operations Management*, 29, 707–720.
- Mason, R. (2013, February 24). Horsemeat Scandal: Supermarkets Have Failed to Check Meat Suppliers, MPs Told. *The Telegraph*.
- McFadden, D. (1974). *Conditional Logit Analysis of Qualitative Choice Behaviour*. Berkeley: University of California.
- Mørkbak, M.R., Christensen, T., & Gyrd-Hansen, D. (2010). Choke price bias in choice experiments. *Environmental and Resource Economics*, 45, 537–551.
- Moser, R., Raffaelli, R., & Thilmany, D. (2011). Consumer preferences for fruit and vegetables with credence-based attributes: A review. *International Food and Agribusiness Management Review*, 14, 121–142.
- Moussa, S., & Touzani, M. (2008). The perceived credibility of quality labels: A scale validation with refinement. *International Journal of Consumer Studies*, 32, 526–533.
- My, N.H.D., Demont, M., & Verbeke, W. (2021). Inclusiveness of consumer access to food safety: Evidence from certified rice in Vietnam. *Global Food Security*, 28, 100491.
- My, N.H.D., Rutsaert, P., Van Loo, E.J., & Verbeke, W. (2017). Consumers' familiarity with and attitudes towards food quality certifications for rice and vegetables in Vietnam. *Food Control*, 82, 74–82.
- My, N.H.D., Van Loo, E.J., Rutsaert, P., Tuan, T.H., & Verbeke, W. (2018). Consumer valuation of quality rice attributes in a developing economy: Evidence from a choice experiment in Vietnam. *British Food Journal*, 120, 1059–1072.
- Navigos Group. (2019). *Salary Survey of Jobseekers in Vietnam*. Retrieved from <https://www.navigosgroup.com/vi/bao-cai-khao-sat-luong>
- Ngo, H.M., Liu, R., Moritaka, M., & Fukuda, S. (2020). Urban consumer trust in safe vegetables in Vietnam: The role of brand trust and the impact of consumer worry about vegetable safety. *Food Control*, 108, 106856.
- Nugraha, W.S., Yang, S.H., & Ujiie, K. (2021). The heterogeneity of consumer preferences for meat safety attributes in traditional markets. *Foods*, 10, 624.
- O'Mahony, P.J. (2013). Finding horse meat in beef products – a global problem. *QJM*, 106, 595–597.
- Ortega, D., Wang, H., Wu, L., & Olynk, N. (2011). Modeling heterogeneity in consumer preferences for select food safety attributes in China. *Food Policy*, 36, 318–324.
- Ortega, D.L., & Tschirley, D.L. (2017). Demand for food safety in emerging and developing countries: A research agenda for Asia and Sub-Saharan Africa. *Journal of Agribusiness in Developing and Emerging Economies*, 7, 21–34.
- Phong, T. N., Tat Thang, V., & Nguyen Trong, H. (2023). The effect of sustainability labels on farmed-shrimp preferences: Insights from a discrete choice experiment in Vietnam. *Aquaculture Economics & Management*, 27(3), 468–497.
- Pieniak, Z., Aertsens, J., & Verbeke, W. (2010). Subjective and objective knowledge as determinants of organic vegetables consumption. *Food Quality and Preference*, 21, 581–588.
- Pizzuti, T., & Mirabelli, G. (2015). The global track & trace system for food: General framework and functioning principles. *Journal of Food Engineering*, 159, 16–35.

- Polinsky, A., & Shavell, S. (1979). The optimal tradeoff between the probability and magnitude of fines. *American Economic Review*, 69, 880–891.
- Pouliot, S. (2011). Market evidence of packer willingness to pay for traceability. *American Journal of Agricultural Economics*, 93, 735–751.
- Pouliot, S., & Sumner, D. (2008). Traceability, liability, and incentives for food safety and quality. *American Journal of Agricultural Economics*, 90, 15–27.
- Pouliot, S., & Sumner, D. (2013). Traceability, recalls, industry reputation and product safety. *European Review of Agricultural Economics*, 40, 121–142.
- Quacert. VietGAP Standard. Retrieved from <https://www.quacert.gov.vn/en/good-agriculture-practice.nd185/vietgap-standard.i88.html>
- Rao, A.R., Qu, L., & Ruekert, R.W. (1999). Signaling unobservable product quality through a brand ally. *Journal of Marketing Research*, 36, 258–268.
- Resende-Filho, M., & Hurley, T. (2012). Information asymmetry and traceability incentives for food safety. *International Journal of Production Economics*, 139, 596–603.
- Rijswijk, W., Frewer, L., Menozzi, D., & Faioli, G. (2008). Consumer perceptions of traceability: A cross-national comparison of the associated benefits. *Food Quality and Preference*, 19, 452–464.
- Ringsberg, H. (2014). Perspectives on food traceability: A systematic literature review. *Supply Chain Management*, 19, 558–576.
- Roth, A., Tsay, A., Pullman, M., & Gray, J. (2008). Unraveling the food supply chain: Strategic insights from China and 2007 recalls. *Journal of Supply Chain Management*, 44, 22–39.
- Saak, A. (2016). Traceability and reputation in supply chains. *International Journal of Production Economics*, 177, 149–162.
- Samapundo, S., Thanh, T.N.C., Xhaferi, R., & Devlieghere, F. (2016). Food safety knowledge, attitudes and practices of street food vendors and consumers in Ho Chi Minh city, Vietnam. *Food Control*, 70, 79–89.
- Sarrias, M., Daziano, R., & Croissant, Y. gmnL: Multinomial Logit Models with Random Parameters. Retrieved from <https://cran.r-project.org/web/packages/gmnL/gmnL.pdf>
- Schwägele, F. (2005). Traceability from a European perspective. *Meat Science*, 71, 164–173.
- Scott, A. (2002). Identifying and analysing dominant preferences in discrete choice experiments: An application in health care. *Journal of Economic Psychology*, 23, 383–398.
- Smith DeWaal, C. (2003). Safe food from a consumer perspective. *Food Control*, 14, 75–79.
- Smith, G., Tatum, J., Belk, K., Scanga, J., Grandin, T., & Sofos, J. (2005). Traceability from a US perspective. *Meat Science*, 71, 174–193.
- Spencer, R. (2009, January 22). Two Sentenced to Death over China Melamine Milk Scandal. *The Telegraph*. Retrieved from <http://www.telegraph.co.uk/news/worldnews/asia/china/4315627/Two-sentenced-to-death-over-China-melamine-milk-scandal.html>
- Starbird, S., & Amanor-Boadu, V. (2004). Traceability, Inspection and Food Safety. American Agricultural Economics Association Annual Meeting, Denver, CO, July 1–4, 2004.

- Suhandoko, A.A., Bin Chen, D.C., & Yang, S.H. (2021). Meat traceability: Traditional market shoppers' preferences and willingness-to-pay for additional information in Taiwan. *Foods*, 10, 1819.
- Sun, S., Wang, X., & Zhang, Y. (2017). Sustainable traceability in the food supply chain: The impact of consumer willingness to pay. *Sustainability*, 9(6), 999.
- Testa, F., Iovino, R., & Iraldo, F. (2024). Digitalization to make environmental information accessible to consumers: The 'barcode for the environment' project. In *Environmentally Responsible Supply Chains in an Era of Digital Transformation* (pp. 189-205). Edward Elgar Publishing.
- Thai, N.T., & Pensupar, K. (2015). Factors affecting consumers' decision to purchase VietGAP vegetables in Hanoi, Vietnam. *Academic Fora*, 24, 54–64.
- Thúy, V.T.N. (2016). Effects of food safety labels on consumer behaviours towards private brand products. *VNU Journal of Science: Economics and Business*, 32(4).
- Tran, D., Broeckhoven, I., Hung, Y., Diem My, N. H., De Steur, H., & Verbeke, W. (2022). Willingness to pay for food labelling schemes in Vietnam: A choice experiment on water spinach. *Foods*, 11(5), 722.
- Tran, D., De Steur, H., Gellynck, X., Papadakis, A., & Schouteten, J. J. (2024). Consumers' valuation of blockchain-based food traceability: role of consumer ethnocentrism and communication via QR codes. *British Food Journal*, 126(13), 72-93.
- United States. (2002). Bioterrorism Act of 2002. Retrieved from <https://www.fda.gov/regulatoryinformation/lawsenforcedbyfda/ucm148797.htm>
- Van Loo, E.J., Caputo, V., Nayga, R.M., Meullenet, J.F., & Rieke, S.C. (2011). Consumers' willingness to pay for organic chicken breast: Evidence from choice experiment. *Food Quality and Preference*, 22, 603–613.
- Van Loo, E.J., Minnens, F., & Verbeke, W. (2021). Consumer preferences for private label brand vs. national brand organic juice and eggs: A latent class approach. *Sustainability*, 13, 7028.
- Vermeulen, B., Goos, P., & Vandebroek, M. (2008). Models and optimal designs for conjoint choice experiments including a no-choice option. *International Journal of Research in Marketing*, 25, 94–103.
- Vietnam Investment Review. Hanoi Eyes QR Codes to Trace Food. Retrieved from <https://www.vir.com.vn/hanoi-eyes-qr-codes-to-trace-food-65791.html>
- Wang, F., Zhang, J., Mu, W., Fu, Z., & Zhang, X. (2009). Consumers' perception toward quality and safety of fishery products, Beijing, China. *Food Control*, 20, 918–922.
- Willer, H., & Lernoud, J. (2019). *The World of Organic Agriculture: Statistics and Emerging Trends 2019*. Frick, Switzerland: FiBL.
- Wongprawmas, R., & Canavari, M. (2017). Consumers' willingness-to-pay for food safety labels in an emerging market: The case of fresh produce in Thailand. *Food Policy*, 69, 25–34.
- World Bank. (2020). *Vietnam Food Safety Risks Management: Challenges and Opportunities* (Vol. 2): Annexes. Retrieved from <http://documents.worldbank.org>
- World Health Organisation. Food Safety. Retrieved from <https://www.who.int/news-room/fact-sheets/detail/food-safety>

- Wu, L., Wang, H., Zhu, D., Hu, W., & Wang, S. (2016). Chinese consumers' willingness to pay for pork traceability information – The case of Wuxi. *Agricultural Economics*, 47, 71–79.
- Wu, L., Wang, H., Zhu, D., Hu, W., & Wang, S. (2016). Chinese consumers' willingness to pay for pork traceability information – The case of Wuxi. *Agricultural Economics*, 47, 71–79.
- Yu, H., Neal, J.A., & Sirsat, S.A. (2018). Consumers' food safety risk perceptions and willingness to pay for fresh-cut produce with lower risk of foodborne illness. *Food Control*, 86, 83–89.
- Zhang, C., Bai, J., & Thomas, W. (2012). Consumers' willingness to pay for traceable pork, milk, and cooking oil in Nanjing, China. *Food Control*, 27, 21–28.
- Zhang, M.Y., Fan, Y.B., Cao, J.X., Chen, L.J., & Chen, C. (2021). Willingness to pay for enhanced mandatory labelling of genetically modified soybean oil: Evidence from a choice experiment in China. *Foods*, 10, 736.
- Zulfikar, K., Xue, J., & Rabbany, G. (2021). Consumers' willingness to pay for GLOBALG.A.P. certified chicken: Empirical evidence from a consumer survey in Bangladesh. *Food Control*, 130, 108397.