

Identifying consumer preferences for sustainable wines in the Netherlands

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Abstract

Worldwide, the wine industry is experiencing a shift to more sustainable production in hopes of capitalising on the changing demand patterns. Existing literature has focused on identifying consumer preferences in purchasing sustainable certified wines and on their willingness to pay (WTP) a price premium for them. The current study aims to contribute to that body of knowledge, adding novelty by focusing on a specific emerging and dynamic market. It analyses Dutch consumers' willingness to buy (WTB) and WTP for sustainable wines by comparing WTB and WTP for different labels (Organic, Sustainable, Natural, Biodynamic and Fairtrade) and applying an innovative approach using the Bayesian Heckman Selection model. Results show that consumers' valuation of certified wines is primarily driven by attitudinal and perceptual factors, while the actual purchasing decision is more strongly conditioned by knowledge, trust, and prior experience. Policy implications include strengthening the credibility of certification schemes through clearer standards, improved traceability, and transparent information provision to reduce informational asymmetries between producers and consumers.

Keywords: Stated preferences, sustainable wines, willingness to buy, willingness to pay, Dutch consumers

JEL codes: C21, Q13, Q56

1 Introduction

Wine companies are facing multiple challenges, including a decrease in wine consumption especially among younger generations [1], and consumers are increasingly aware of the importance of sustainability attributes particularly regarding food products [2,3]. For wine, different sustainable labels have been developed to help consumers make purchase decisions based on their preferences [4]. Certifications serve as signals covering almost all dimensions of sustainability (ethical, social, or environmental) and are supposed to create trust [5,6], but the diversity of signals also creates confusion for consumers due to their different specifications [7]. Among the many certifications aimed at differentiating wines for their sustainability attributes, organic certification appears to be the most prevalent one in the wine industry [8] even though it still represents a small part of total wine production worldwide. As of 2024, the global organic viticultural area reached approximately 9.8% of the total, with organic wine sales estimated to account for around 4.1% of the global market [9].

In this specific context, the Netherlands stands out as a particularly important and dynamic market. While many traditional wine-consuming nations have seen stagnation or slight declines, the Netherlands has consistently demonstrated an increasing trend in both wine consumption and imports [9]. This upward trajectory is even more pronounced for sustainable wines. For instance, recent data from Skal Biocontrole, the Dutch organic certification body, indicates that the market share of organic wines in the Netherlands has seen robust growth. Sales volumes for organic wines increased by an estimated 7.2% in 2024 compared to the previous year, now representing approximately 9.5% of the total Dutch wine market [10]. Similarly, Fairtrade wine sales in the Netherlands have shown consistent expansion, benefiting from strong consumer awareness and demand for ethically produced goods [11]. This cumulative growth across organic and Fairtrade segments, alongside growing interest in biodynamic and natural wines, underscores a broader trend of increasing market share for sustainable wines in the Netherlands [12].

A large body of literature has already explored consumers' willingness-to-buy (WTB) and willingness-to-pay (WTP) providing some insights for the main wine producing and consuming countries. The purpose of this paper is to analyse WTB and WTP for five different labels of sustainable wines (Organic, Sustainable, Natural, Biodynamic and Fairtrade) in the dynamic but still emerging Dutch market. It does so by applying an innovative approach based on the Bayesian Heckman Selection model.

The paper is organised as follows. Section 2 offers a literature review of consumers' WTB and WTP for sustainable wines. Section 3 presents the data and descriptive statistics. Section 4 presents the methodology. Section 5 shows the empirical results, and Section 6 concludes.

2 Consumers' preferences for sustainable certified wines

2.1 Literature review: WTB and WTP for certified wines

The literature is still ambivalent on the influence of sustainable certifications on consumers' WTB or WTP for such wines. Research often only focuses on sustainable wines in general [13] or deals with one dimension of sustainability, while comparative studies are missing [14,15]. Regarding the specific premium, quantified by WTP, Alonso Ugaglia et al. [16] compare different labels and focus on the identification of five main ones (Biodynamic, Organic, Natural, Sustainable and Fairtrade). The study further found significant differences across labels in the WTB and subsequent WTP of French wine consumers. Some authors find a positive effect of sustainability signals [17,18,19,20], others show no effect [21] or a negative one [22,23] making the marketing implications for producers unclear. The literature provides insights into characteristics of wine consumers with a positive WTP for sustainable labels: women [19], young consumers [8,19,24] or millennials [25] represent the main consensus. Wine knowledge [26], marital status (with unmarried people willing to pay more), high education level, high income level [27], the likelihood of buying eco-certified goods [28], the price consumers usually pay for wine, the occasion related to the purchase, lifestyle, consumption frequency and the link to wine tourism also have positive effects. However, when the product is much more expensive, the attitudinal factors become weaker influences. Therefore, a higher price for a sustainable product may become a barrier for consumers to purchase [29]. Mueller Loose and Remaud [30] finally show that sustainability concerns vary strongly between consumers in different markets, highlighting the relevance of market-specific studies [5].

2.2 Certified wines in the Dutch wine market

The Netherlands, while not a top wine-producing nation, nor historically a leading consumer, has carved out a unique position due to its consistently expanding wine market. As a matter of fact, total wine consumption in the Netherlands reached approximately 4.1 million hectoliters in 2023 [31]. This sustained growth is largely driven by imports, which show robust expansion (+5.2% in volume and 8.7% in value in 2023), underscoring the market's dynamism and increasing sophistication [31]. However, this trend seems to have slowed down in 2024.

In the Netherlands the gender distribution for wine consumption is fairly equal, both in number of consumers and in amount of wine consumed. The propensity for wine consumption increases with age [32]. Recent figures indicate that per capita wine consumption in the Netherlands stands at approximately 23.5 litres per year [31]. This translates to an average daily consumption closer to one standard glass per adult, reflecting global trends. Characteristically, wine consumers in the Netherlands often possess an intermediate to high level of education and exhibit a greater engagement with arts, culture, and travel compared to the general population [32,33]. This demographic profile suggests a consumer base that is potentially more discerning and open to premium or differentiated products, including sustainable options. Dutch consumers are indeed increasingly inclined to purchase wines that have been produced using sustainable practices. Frequent Dutch wine consumers are also 4% more likely to purchase healthier and sustainable certified food and beverages, wine included [34].

Various categories of sustainable wines, including Biodynamic, Fairtrade, Organic, Natural, Sustainable (see [16] for definitions) and other certified sustainable options, are increasingly prominent in the Dutch market [12]. In the Netherlands, importers are increasingly interested in wines with sustainable certifications. As an example, Verbunt Verlinden [35] focuses on Corporate Social Responsibility (CSR) by buying from wineries certified in organic or biodynamic viticulture and/or wineries with sustainable and Fairtrade certificates. Coenecoop Wine Traders, one of the largest importers of organic wine in the Netherlands, predicts that sustainable certified wines will become the future norm on the wine market rather than an exception. They mainly sell Organic, Biodynamic and Fairtrade certified wines [36]. Considering local wine production in Dutch wineries, the concept of organic wines has also been fully incorporated into the wine production process. Thanks to the emergence of mildew-resistant grape varieties that ripen early, organic wine production is also growing in the Netherlands [37].

3 Data and descriptive statistics

To identify the determinants of WTB and WTP for five types of sustainably certified wines (Biodynamic, Fairtrade, Organic, Natural, and Sustainable) in the Netherlands, a cross-sectional research design was applied, using the contingent valuation method, a stated preference approach. Stated preference approaches ask consumers about their hypothetical WTB and WTP for specific goods or services [38]. The data were collected through a survey administered

online to obtain information from a broad sample of wine drinkers and to reach a diverse group of respondents in terms of age, gender, and income.

The survey consisted of closed-ended discrete choice and Likert-scale questions and was structured into three sections. The first section focused on respondents' backgrounds and wine purchasing and consumption habits. The second section gathered information on consumers' perspectives and opinions regarding sustainable certifications. The final section included demographic questions. Each certification was clearly defined and explained, and respondents stated their WTB and WTP for each label separately to minimise potential substitution effects in their decision-making process. For the WTP questions, a payment ladder approach was used, allowing participants to select from predetermined price categories.

The sample comprised 210 respondents, of whom 61% were female, with the majority aged between 25 and 39 years (millennials). Most respondents were married (42%) or cohabiting (32%). The largest income group (34%) fell into category 3 (€2,500 to €5,000 per month). On average, respondents purchase seven bottles of wine per month at an average price of €7.43, placing them in the lower price segment. When asked directly, respondents reported an average annual wine expenditure of €661¹. Overall, the sample characteristics are broadly consistent with the profile of Dutch wine consumers described in the literature [32,33].

4 Methodology

First, descriptive statistics are used to present WTB and WTP across the five certification labels. Second, a Kruskal–Wallis test is conducted to assess whether average WTP differs among the five certification schemes, as the WTP variable does not follow a normal distribution². We begin by analysing consumers' WTB for certified wine and subsequently examine their WTP³. Since WTP is observed only for respondents who express a positive purchasing intention, the analysis may be subject to sample selection bias. Specifically, the participation decision (WTB) is non-random and may be correlated with unobserved factors, such as trust in certification schemes, that also influence WTP. As a result, conventional regression techniques could

¹ This data was collected as a separate survey item; the slight difference from a simple product of monthly bottles and price reflects rounding in the categorical responses and the direct-expenditure question capturing a broader scope of purchasing.

² Both the Kolmogorov-Smirnov and the Shapiro-Wilk test revealed the non-normal distribution of the WTP.

³ WTP is measured as a continuous variable ranging from 1 to 6, reflecting the price premium that consumers are willing to pay.

produce biased and inconsistent estimates. To address this issue, we apply the Heckman sample selection model originally proposed by Heckman [39], defined as follows:

$$y_i^* = x_i' \beta + u_i \quad (1)$$

$$z_i = 1(w_i' \gamma + \varepsilon_i > 0) \quad (2)$$

$$y_i = z_i y_i^* \quad (3)$$

Where x_i' denotes a vector of independent observed variables, influencing the latent outcome y_i^* (WTP), and u_i defines the error term in the outcome regression equation (1). z_i is the selection equation, in our case an observed binary variable (WTB) indicating whether the participant is willing to buy the certified wine ($z_i = 1$) or not ($z_i = 0$), with explanatory variables given by the vector w_i' , while ε_i is the error term of the selection equation (2).

Therefore, y_i is observed when $w_i' \gamma + \varepsilon_i > 0$, or when $z_i = 1$, as in equation (3). In this model, both u_i and ε_i capture the aggregated effects of the unobserved terms and are assumed to follow a conditional bivariate normal distribution, expressed by

$$\begin{pmatrix} u_i \\ \varepsilon_i \end{pmatrix} | x_i, w_i \sim N \left(\begin{pmatrix} 0 \\ 0 \end{pmatrix}, \begin{pmatrix} \sigma_u^2 & \rho \\ \rho & 1 \end{pmatrix} \right) \quad (4)$$

Where σ_u^2 is the variance of u_i , while the variance of ε_i is normalised to 1 in the probit selection equation and ρ is the covariance between u_i and ε_i . If $\rho \neq 0$, ordinary least squares estimation of the outcome equation suffers from selection bias.

In the Heckman model the identification condition, which ensures that distinct parameter values correspond to distinct probability distributions of the observable data, requires at least one exclusion restriction. An exclusion restriction is defined as a variable that enters the selection equation but is excluded from the outcome equation [40]. In our case, economic, environmental, and social reasons are conceptualized as normative motivations that influence the participation decision (WTB) for certified wine but do not directly determine the conditional WTP once the purchase decision has been made. As indicated by Jensen et al. [41] and Gracia and de Magistris [42], positive stances towards the environment significantly influence the probability of buying organic foods but do not influence the specific price premium. The latter is significantly influenced by product specific attributes. This is further supported by research undertaken by Padilla Bravo et al. [43], which found that while altruistic motives drive the decision to buy organic, the income and budget restrictions play a far larger role in WTP. These variables

therefore serve as exclusion restrictions, affecting the selection process without directly shifting the conditional mean of the outcome equation.

It should be noted that while many of the same observed covariates appear in both equations, the theoretical distinction between WTB and WTP rests on the presence of exclusion restrictions - specifically, the normative motivation variables (economic, environmental, and social reasons) - which enter the selection equation but are excluded from the outcome equation. This is consistent with the approach of Lanfranchi et al. [24], who apply a similar sample selection framework in the wine context. The shared covariates reflect the reasonable expectation that the same consumer characteristics can shape both decisions, but the estimated parameter magnitudes and credible intervals differ substantially across equations, confirming heterogeneous effects.

The classical Heckman selection approach addresses sample selection bias through a two-step estimation procedure. However, given the moderate sample size (210 observations), it may suffer from convergence issues, inflated standard errors, and imprecise inference [40]. Moreover, violations of the distributional assumptions can further distort the estimates [44]. To overcome these limitations, we employ a Bayesian Heckman selection model [45,46]. While maintaining the same structural specification (equations and variables) as the classical model, the Bayesian approach provides full posterior distributions rather than point estimates and allows for a direct probabilistic interpretation of parameter uncertainty through credible intervals [40,45]. It also enhances numerical stability in complex and highly parameterized models and permits the incorporation of prior information [45]. Using the routine available in Stata 18.5 [47], the Bayesian Heckman model is estimated via a Random-Walk Metropolis–Hastings Markov Chain Monte Carlo (MCMC) algorithm, assuming diffuse normal priors for all parameters⁴. To assess the sensitivity of the estimates to these assumptions, we complement the Bayesian Heckman model with two sets of robustness checks: first, we characterise the distribution of the residuals of both equations and re-estimate the outcome equation by ordinary least squares [49] and by a Heckman selection-t model [50]; second, the WTB selection

⁴ The application of LASSO or Elastic Net for variable selection was considered but deemed incompatible with the present modeling framework for three reasons: the variable set is theory-driven rather than exploratory, with each regressor grounded in the established consumer behaviour literature; the collinearity diagnostics allow us to rule out over-parameterization in the chosen specification; and standard penalized regression cannot be applied to a joint Heckman selection model without invalidating the exclusion restrictions and the structural link between the selection and outcome equations. Within the Bayesian framework, posterior credible intervals serve the function of distinguishing precisely from imprecisely estimated effects without hard-zero shrinkage, providing a continuous and interpretable measure of parameter relevance. Future research with substantially larger samples might productively explore penalized extensions of sample selection models [48].

equation is re-estimated as a probit on the full sample after multiple imputation of the missing covariates by chained equations [51].

5 Results

5.1. Descriptive results

Most respondents are familiar with at least one of the five certifications, with only 3.3% indicating no prior awareness. Organic certification is by far the most recognised (93.3%) and also the most frequently purchased (75%). Overall, 87% of respondents report having previously bought at least one certified wine.

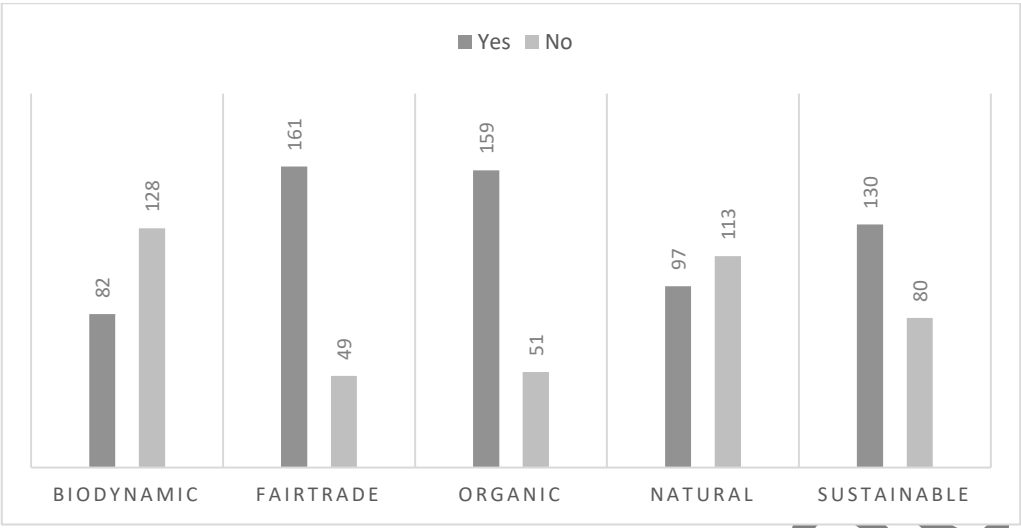
Regarding purchasing channels, 54% buy wine in liquor or specialty stores or directly from wineries, 38% in supermarkets, and 8% online. One third of respondents report basic wine knowledge, while nearly half indicate higher levels of knowledge.

WTB varies across certifications (Figure 1), and average WTP is highest for Fairtrade wines, followed by Organic wines, while Biodynamic wines show the lowest additional premium (Figure 2). The Kruskal–Wallis⁵ test confirms significant differences in WTP across certification types, supporting the existence of heterogeneous consumer valuations. Given these results, the pairwise Mann-Whitney U tests with Bonferroni correction were subsequently applied as post-hoc comparisons to pinpoint which label pairs drove the overall difference. This test reveals that WTP was significantly higher for Fairtrade, Organic, and Sustainable compared to Biodynamic (all $p\text{-adj} \leq 0.0001$), while Fairtrade and Organic also commanded significantly higher WTP than Natural ($p\text{-adj} = 0.0028$ and $p\text{-adj} = 0.0058$, respectively), and Natural showed significantly lower WTP than Sustainable ($p\text{-adj} = 0.0309$); no significant differences emerged among Fairtrade, Organic, and Sustainable, nor between Biodynamic and Natural, suggesting that consumers perceive these latter two as equivalent low-premium certifications.

⁵ Chi2(4) = 37.965, Probability = 0.0001; Chi2(4) with ties = 41.852, Probability = 0.0001.

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Figure 1: Willingness to buy certified wine (total answers)

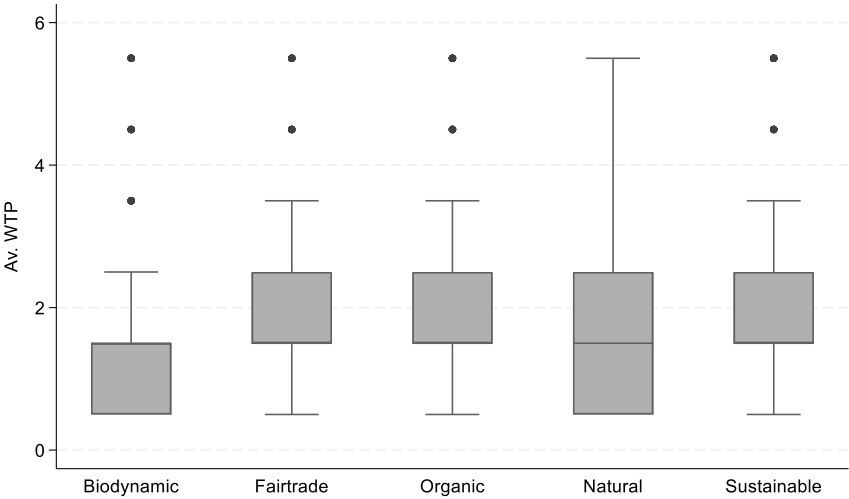


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Figure 2: Willingness to pay for certified wine (amount additional to current price)



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Overall, these descriptive findings reveal that Dutch wine consumers display heterogeneous valuations of sustainable certifications — with Fairtrade, Organic, and Sustainable commanding statistically equivalent and significantly higher price premiums than Biodynamic and Natural — underscoring that consumer WTP is shaped not merely by the rigor of the certification scheme but by its visibility, perceived credibility, and degree of market familiarity. Since WTP is observed only for respondents with positive WTB, and given the significant variation between labels, the use of the Bayesian Heckman specification is justified to account

for potential sample selection bias. The full estimation results are provided in the appendix (Table A1)⁶, while Table 1 summarises the main parameter signs.

Table 1: Signs of the parameter estimates from the Bayesian Heckman model

Variables	Biodynamic	Fairtrade	Organic	Natural	Sustainable
WTP_ (Outcome)					
Age	0	0	-	0	0
Gender	0	+	+	+	+
Education	+	+	0	0	-
Income	-	+	0	0	0
Marital	0	0	-	-	+
How often	0	0	0	0	+
Knowledge	0	0	0	0	0
Heard	0	0	+	+	-
Bought	-	0	+	+	0
Imp	+	+	+	+	+
Events Special	0	-	+	0	0
WTB_ (Selection)					
Age	-	-	-	-	0
Gender	0	0	-	0	0
Education	0	+	0	-	-
Income	0	+	+	0	0
Marital	0	0	-	0	0
How often	0	0	+	+	+
Knowledge	0	-	0	0	0
Heard	0	0	-	+	0
Bought	0	0	+	+	0
Imp	+	+	+	+	+
Events Special	+	-	+	0	0
Economic Reasons	0	0	-	-	0
Environment reasons	+	-	-	0	+
Social reasons	0	0	+	0	0
# obs: selected/non selected (1)	75/115	144/42	145/41	87/99	116/68
Acceptance rate (%)	29.3	29.00	37.11	30.96	30.74

(1) The row '# obs: selected/non selected' in Table 1 refers to the number of respondents included in the Bayesian Heckman model estimation for each label, after listwise deletion of missing values across all covariates.

Acceptance rates fall within recommended ranges for efficient posterior exploration: about 29% for Biodynamic and Fairtrade, 31% for Natural and Sustainable, and 37% for Organic, indicating well-behaved chains and good convergence.

⁶ To assess potential multicollinearity among the regressors, Appendix Table A2 reports the condition number of the regressor matrix [52] together with the variance inflation factor (VIF) of each regressor. Across the five labels the condition number ranges from 2.4 to 2.8, well below the threshold of 20, so multicollinearity is not a source of concern. This is corroborated by the variance inflation factors, which remain low throughout (maximum VIF of 2.09 for Biodynamic and no VIF above 2.1 across labels, with label means between 1.32 and 1.43), well under the conventional threshold of 5. The near-unity ρ estimates therefore reflect correlation between the unobserved determinants of WTB and WTP rather than a collinearity artefact. Robustness to the normality assumption is examined in Section 5.1, while the stability of the selection-equation estimates under both listwise deletion and multiple imputation is included in Appendix Table A5.

The correlation parameter ρ is consistently large (≈ 1) and positive across models, showing a strong link between unobserved factors affecting WTB and WTP. Consumers more likely to purchase also tend to report higher WTP.

The standard deviation σ of the WTP error term varies across labels, ranging from 1.19 (Organic) to 1.90 (Natural), with others between 1.4 and 1.8. Lower σ (Organic) indicates more homogeneous and predictable valuations, while higher σ (Natural, Biodynamic, Sustainable) reflects greater heterogeneity and uncertainty. These patterns signal differences in market maturity and consumer understanding: established labels show tighter WTP distributions, whereas newer or more complex certifications display broader valuation profiles. This highlights where improved communication and certification clarity may help stabilise demand.

Because the correlation parameter approaches unity ($\rho \approx 0.9999$), we examined the distribution of the residuals of the outcome (WTP) equations [49,50]. The null hypothesis of normality is rejected (Appendix Table A3). The WTP residuals are right-skewed (skewness ≈ 1.0 – 1.4) and leptokurtic (excess kurtosis up to ≈ 2.8), with Shapiro–Wilk and Jarque–Bera tests rejecting normality ($p < 0.001$). As departures from normality can push ρ towards its boundary, we re-estimated the outcome equation (Appendix Table A4) using ordinary least squares [49] versus Heckman two-step estimates. In this estimation, the inverse Mills ratio is statistically non-significant in four of the five outcome equations – Biodynamic, Fairtrade, Organic and Sustainable (p between 0.318 and 0.844) – and significant only for Natural ($p = 0.010$), indicating that the selection correction is weakly identified for most labels.

The results also show that the sign and significance of the main determinants (importance, prior awareness and purchase) are preserved across the OLS, selection-t and Bayesian Heckman specifications. The Bayesian Heckman results are therefore retained as our primary specification while these alternatives confirm the substantive conclusions.

The estimation sample excludes incomplete cases through listwise deletion, which removes 28 of the 210 respondents, mainly owing to item non-response on income and the label-specific importance items. To verify that this does not drive the results, we re-estimated the WTB selection equation as a frequentist probit on the full sample after imputing missing covariates through Multivariate Imputation by Chained Equations (MICE; $m = 20$; IterativeImputer with a BayesianRidge estimator), pooling estimates by Rubin’s rules [53] (see Appendix Table A5). The principal determinants are stable in sign and significance: the perceived importance of certification and prior awareness remain positive and strong across labels, and the estimates on the imputed sample are close to the listwise ones.

5.2. Influence on the purchase decision (WTB)

The results of the WTB (selection equation) show that attitudinal alignment is the strongest and most consistent determinant of market participation. The perceived importance of certification positively influences WTB across all five labels, confirming that value alignment is essential for entering the certified wine market. Normative motivations vary by label: environmental concerns increase WTB for Biodynamic and Sustainable wines but reduce it for Organic and Fairtrade, while economic considerations act as barriers, particularly for Organic and Natural wines.

The negative association between the environmental motive and WTB for Organic and Fairtrade is plausibly a substitution effect across the mutually exclusive motive categories: respondents who single out the environment as their primary reason appear to map that motive onto the explicitly “green” labels (Biodynamic and Sustainable, both positive) rather than onto Organic - a highly familiar, mainstream category [27] - or onto Fairtrade, whose salience is socio-ethical rather than environmental [22]. This pattern is consistent with Stern’s [29] value-belief-norm framework, in which environmentally significant behaviour is channelled towards the options consumers most readily associate with the activated norm. Consistent with this being a smaller and noisier sub-group effect, the environmental-motive coefficient is among the least stable under the multiple-imputation robustness check. The opposite signs of prior awareness (Heard) for Organic - negative in the WTB (selection) equation but positive in the WTP (outcome) equation - are readily reconciled within the selection framework [39]. In a saturated category in which 93.3% of respondents are aware of the Organic label, awareness no longer distinguishes buyers at the participation margin, so its marginal effect on WTB is weak or negative; conditional on purchasing, however, better-informed consumers assign a higher premium, yielding a positive effect on WTP, in line with evidence that information provision raises valuations for organic products [42].

Experience and familiarity also play a central role in shaping WTB. Consumers who frequently purchase certified food are more likely to buy Organic, Natural, and Sustainable wines, indicating spillover effects from habitual sustainable consumption [43]. Prior purchase experience reinforces WTB for Organic and Natural wines, suggesting trust formation and habit persistence [41]. Awareness increases WTB for Natural wines but reduces it for Organic, possibly reflecting market saturation or greater scrutiny in established categories [20]. Higher knowledge levels reduce WTB for Fairtrade, implying more critical evaluation among informed consumers [6].

Socio-economic characteristics exert weaker and more heterogeneous effects. Age is generally negative, indicating that younger consumers are more inclined to purchase certified wines. Education increases WTB for Fairtrade but decreases it for Natural and Sustainable wines, potentially reflecting scepticism towards less clearly defined certifications. Income positively influences Fairtrade and Organic purchases, consistent with their stronger premium positioning, while gender and marital status show limited impact. This is supported by Vecchio [13], who observed that as sustainable labels become mainstream, purchasing behaviour becomes more dependent on psychographic rather than demographic variables.

Overall, the selection equation indicates that willingness to buy is primarily experience-driven and value-based rather than purely income-dependent. This is supported by the findings of Sogari et al. [23] that factors such as involvement and curiosity have a strong influence in the purchase of sustainable products. Participation reflects processes of learning, trust formation, and ethical alignment, with clear differences across certification types. These findings confirm that entry into the sustainable wine market depends more on familiarity and perceived credibility than on socio-demographic status alone.

5.3. WTP for sustainable wines

The WTP (outcome equation) shows that attitudinal and perceptual factors emerge as the most robust and consistent drivers of WTP across all wine categories. The variable *Importance* is positive and relevant for all labels, confirming that consumers who place greater importance on certification attributes are willing to pay higher premiums. This finding is fully consistent with utility theory, as stronger preference intensity directly translates into higher marginal willingness to pay. It further supports the notion that consumers use extrinsic cues like labels to reduce quality uncertainty, being willing to pay a premium only when these cues are perceived as credible signals of quality or environmental benefit [54].

Socio-economic characteristics play a secondary but heterogeneous role. Women exhibit higher WTP for most certifications, consistent with findings that female consumers tend to display stronger pro-environmental preferences [55,56]. Education increases WTP for Biodynamic and Fairtrade wines, suggesting that more complex or ethically framed labels appeal to more informed consumers. Income matters mainly for Fairtrade, while age effects are weak, contrasting with earlier studies that found stronger premiums among younger consumers [8,19,24].

Knowledge and experience reinforce valuation, particularly for established labels. Awareness and prior purchase increase WTP for Organic and Natural wines, highlighting the importance of information and trust formation in markets characterised by credence attributes [26]. In contrast, prior purchase reduces WTP for Biodynamic wines, possibly reflecting unmet expectations or perceived price–quality mismatches. Information exposure through special events can either strengthen or weaken WTP depending on the label’s perceived credibility.

Overall, WTP for sustainable wines in the Netherlands is primarily value-driven and experience-reinforced, with clear differentiation across certifications. The results confirm that sustainability labels are not treated as homogeneous signals; rather, credibility, familiarity, and clarity determine the strength and stability of price premiums [5,16].

6 Conclusion

This study analyses Dutch consumers’ willingness to buy (WTB) and willingness to pay (WTP) for five sustainable wine labels (Biodynamic, Fairtrade, Organic, Natural, and Sustainable), explicitly comparing differences across certifications. The findings indicate that Dutch consumers generally express a positive valuation of certified wines; however, both participation and price premiums vary substantially across labels. Certifications are therefore not perceived as interchangeable signals, and consumer responses depend on familiarity, perceived credibility, and value alignment. The findings show that attitudinal importance and prior experience are the most consistent drivers of WTP, while knowledge, familiarity, and normative motivations shape the decision to enter the certified wine market. Participation and valuation decisions appear to be linked, although the estimated correlation between the two equations lies close to the boundary of its range. Robustness checks using alternative estimators (ordinary least squares and a Heckman selection-t model) confirm that the substantive findings are not sensitive to this feature.

From a policy perspective, the results suggest that improving clarity, transparency, and communication around certification schemes may help reduce uncertainty and strengthen consumer confidence, particularly for less established labels. However, the findings are based on stated preference data and reflect perceived rather than observed market behaviour. Therefore, policy recommendations should be interpreted as indicative rather than prescriptive. Strengthening information provision and traceability mechanisms may support market development, but their actual impact on revealed purchasing behaviour remains to be empirically validated. From a managerial standpoint, the evidence indicates that sustainability

positioning alone is unlikely to generate stable premiums without complementary efforts to build trust and familiarity. Experience-based marketing tools, such as tastings, targeted in-store communication, and educational initiatives, may facilitate the conversion of sustainability values into repeat purchases.

Future research should address the main limitations of the study. First, the use of contingent valuation introduces potential hypothetical bias; experimental auctions, scanner data, or field experiments would allow validation with revealed preferences. Second, the cross-sectional design and moderate sample size limit causal inference and generalizability; larger samples would also enable the exploration of penalised extensions of sample selection models — such as adaptive LASSO [48] or equivalence-based selection approaches — as data-driven complements to the Bayesian framework. Third, while we assessed robustness to the normality assumption and to missing data through alternative estimators and multiple imputation, the near-unity correlation between the two equations indicates that the selection correction is weakly identified in this sample; larger datasets would permit sharper identification and a fuller comparison of selection-model variants. Fourth, comparative cross-country analyses would help determine whether the observed heterogeneity across labels reflects structural market maturity patterns or country-specific institutional and cultural factors. Finally, two survey-related limitations merit attention. The sample may be subject to self-selection bias: individuals with stronger sustainability interests are both more likely to participate in this type of study and to exhibit higher WTP for sustainably produced goods [57], so both effects operate in the same direction and may produce upwardly biased estimates relative to a fully representative sample; quota-based or probability sampling designs would help mitigate this in future work. Additionally, a systematic gap between stated WTP and actual market prices warrants caution: the premia charged by organic and biodynamic producers are considerably lower than those reported in stated-preference studies [57], suggesting that some producers may deliberately forgo profit maximisation in pursuit of non-pecuniary objectives - a pattern documented in the California wine industry by Scott Morton and Podolny [58] and linked to sustainable certification strategies by Delmas and Gergaud [59] - and reinforcing the value of complementing contingent valuation evidence with revealed market-price analyses.

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643 **Appendix**644 *Table A1: Estimates from the Bayesian Heckman selection model—means and 95% credible*
645 *intervals in parentheses*

Variables	Biodynamic	Fairtrade	Organic	Natural	Sustainable
WTP_ (Outcome)					
Age	-0.1218 (-0.303, 0.062)	-0.1760 (-0.315, 0.071)	-0.0970 (-0.191, -0.007)	-0.0356 (-0.213, 0.199)	-0.0027 (-0.112, 0.119)
Gender	0.2293 (-0.159, 0.583)	0.3836 (0.130, 0.650)	0.2861 (0.085, 0.444)	0.6646 (0.396, 1.007)	0.2588 (0.012, 0.478)
Education	0.4050 (0.144, 0.804)	0.1951 (0.046, 0.348)	0.0087 (-0.083, 0.115)	0.0816 (-0.382, 0.103)	-0.0957 (-0.198, -0.001)
Income	-0.2997 (-0.539, -0.036)	0.2900 (0.138, 0.436)	0.0551 (-0.045, 0.152)	-0.1129 (-0.382, 0.103)	-0.1893 (-0.469, 0.041)
Marital	-0.3597 (-0.811, 0.291)	-0.0640 (-0.362, 0.188)	-0.1574 (-0.253, -0.085)	-0.4849 (-0.764, -0.240)	0.4897 (0.296, 0.647)
How often	-0.1610 (-0.606, 0.304)	-0.0756 (-0.192, 0.051)	0.0372 (-0.048, 0.116)	0.1889 (-0.152, 0.512)	0.3904 (0.222, 0.600)
Knowledge	-0.0793 (-0.240, 0.044)	-0.0886 (-0.190, 0.007)	-0.0197 (-0.103, 0.053)	-0.051 (-0.217, 0.153)	0.0476 (-0.168, 0.243)
Heard	0.6319 (-0.033, 1.185)	0.3671 (-0.028, 0.824)	0.3100 (0.151, 0.469)	0.6796 (0.379, 0.998)	-0.4546 (-0.823, -0.108)
Bought	-0.9909 (-1.531, -0.226)	0.0142 (-0.290, 0.353)	0.4177 (0.279, 0.549)	0.2988 (0.031, 0.608)	0.1159 (-0.099, 0.283)
Imp	0.6194 (0.436, 0.820)	0.437 (0.307, 0.563)	0.4606 (0.388, 0.548)	0.1943 (0.001, 0.348)	0.2774 (0.176, 0.388)
Events_Special	0.0384 (-0.401, 0.508)	-0.9860 (-1.181, -0.802)	0.264 (0.097, 0.417)	-0.0737 (-0.512, 0.249)	-0.2267 (-0.535, 0.054)
WTB (Selection)					
Age	-0.1854 (-0.370, -0.072)	-0.2530 (-0.378, -0.129)	-0.1473 (-0.215, -0.070)	-0.1262 (-0.228, -0.029)	-0.0475 (-0.110, 0.019)
Gender	-0.2252 (-0.480, 0.051)	-0.0473 (-0.152, 0.086)	-0.5452 (-0.635, -0.432)	0.0590 (-0.137, 0.208)	-0.1454 (-0.324, 0.069)
Education	-0.0677 (-0.264, 0.074)	0.1738 (0.059, 0.289)	-0.0796 (-0.177, 0.024)	-0.0961 (-0.187, -0.018)	-0.1953 (-0.320, -0.063)
Income	-0.0372 (-0.179, 0.147)	0.3035 (0.231, 0.375)	0.0896 (0.015, 0.173)	-0.0932 (-0.224, 0.032)	0.0069 (-0.075, 0.083)
Marital	-0.1549 (-0.367, 0.140)	-0.0030 (-0.166, 0.145)	-0.2042 (-0.454, -0.102)	0.0273 (-0.112, 0.244)	0.0669 (-0.117, 0.269)
How often	0.1074 (-0.734, 0.326)	0.0905 (-0.049, 0.235)	0.1923 (0.105, 0.271)	0.1739 (0.038, 0.352)	0.2276 (0.117, 0.314)
Knowledge	-0.0032 (-0.096, 0.073)	-0.1483 (-0.237, -0.061)	-0.0360 (-0.121, 0.035)	-0.0160 (-0.110, 0.082)	-0.0087 (-0.118, 0.094)
Heard	0.0739 (-0.161, 0.473)	0.0545 (-0.195, 0.288)	-0.1896 (-0.397, -0.025)	0.2871 (0.127, 0.425)	0.0611 (-0.072, 0.174)
Bought	-0.2569 (-0.835, 0.126)	-0.0024 (-0.157, 0.155)	0.3436 (0.187, 0.477)	0.1829 (0.012, 0.448)	-0.1328 (-0.242, 0.018)
Imp	0.2556 (0.127, 0.428)	0.1626 (0.026, 0.323)	0.373 (0.265, 0.470)	0.1268 (0.018, 0.214)	0.2096 (0.091, 0.281)
Events_Special	0.3280 (0.087, 0.565)	-0.7933 (-1.004, -0.590)	1.209 (1.061, 1.327)	0.1948 (-0.001, 0.376)	0.0098 (-0.095, 0.176)
Economic Reasons	-0.0195 (-0.314, 0.302)	-0.0018 (-0.101, 0.096)	-0.2556 (-0.499, -0.097)	-0.2353 (-0.371, -0.026)	-0.1299 (-0.293, 0.053)
Environment reasons	0.1418 (0.124, 0.296)	-0.1850 (-0.345, -0.028)	-0.3156 (-0.423, -0.204)	0.1931 (-0.527, 0.146)	0.1439 (0.013, 0.276)
Social reasons	-0.0909 (-0.486, 0.167)	0.1535 (-0.129, 0.470)	0.1451 (0.078, 0.216)	0.0908 (-0.154, 0.286)	-0.0443 (-0.157, 0.078)
# obs: selected/non selected	75/115	144/42	145/41	87/99	116/68
Acceptance rate (%)	29.30	29.00	37.11	30.96	30.74
Athrho	8.0672 (1.036, 17.622)	10.637 (3.258, 18.084)	10.7497 (3.448, 18.142)	8.2144 (1.734, 17.839)	9.9327 (2.433, 18.131)
Rho=tanh(athrho)	0.9999	0.9999	0.9999	0.9999	0.9999
lnsigma	0.5766 (0.314, 0.758)	0.3599 (0.255, 0.467)	0.1711 (0.061, 0.282)	0.6429 (0.454, 0.834)	0.6805 (0.474, 0.759)
Sigma (σ)=exp(lnsigma)	1.7799	1.4333	1.1867	1.9021	1.8377

Notes:

- a) Results from Stata software 18.5
- b) *Mean*. The value of the parameters refers to the average of the MCMC (Markov Chain Monte Carlo) posterior draws for each parameter. If the interval does not include zero, the parameter is credibly different from zero, providing posterior support for either a positive or negative effect. A narrow interval indicates high precision (more information), whereas a wide interval indicates lower precision (less information).
- c) *Acceptance rate*. Is the percentage of proposed MCMC moves that are accepted. The optimal theoretical acceptance rate is approximately 23% [60].
- d) $Athrho = atanh(\rho)$, with $\rho = tanh(athrho)$. A correlation coefficient $\rho \approx 1$ indicates a strong positive correlation between the unobserved determinants of WTB and WTP, confirming substantial sample selection bias and validating the Heckman selection model. It reflects a pattern in the data whereby consumers unobservably more inclined to buy certified wine are simultaneously willing to pay a higher premium through those same unobserved channels — such as trust, environmental values, or lifestyle alignment
- e) $lnsigma = log(\sigma)$. Represents the logarithm of the standard deviation of the error term in the outcome equation, where $exp(ln\sigma)$ captures the unexplained variation in WTP after accounting for the observed explanatory variables.

Table A2 (collinearity diagnostics): Condition number and variance inflation factors of the WTB/WTP regressors by label

Label	Condition number	Max VIF	Mean VIF	n (complete cases)
Biodynamic	2.81	2.09	1.43	190
Fairtrade	2.36	1.77	1.33	186
Organic	2.42	1.76	1.33	186
Natural	2.48	1.76	1.36	186
Sustainable	2.47	1.76	1.32	184

Notes: Multicollinearity diagnostics computed on the regressor set common to the selection (WTB) and outcome (WTP) equations — the shared demographics (Age, Gender, Education, Income, Marital, HowOften, Knowledge), the label-specific Heard, Bought, and Imp. items, and the four context dummies (Events, Special, Economic, Environment and Social reasons). The condition number is defined as the square root of the ratio of the largest to the smallest eigenvalue of the regressor correlation matrix [52]. The variance inflation factor (VIF) for each regressor is $1/(1 - R^2)$ from its auxiliary regression on the remaining regressors.

Table A3 (residual normality): Skewness, kurtosis, and normality tests of the OLS outcome residuals

Label	Skewness	Excess kurtosis	Shapiro–Wilk p	Jarque–Bera p
Biodynamic	1.232	1.763	0.0000	0.0000
Fairtrade	1.046	1.278	0.0000	0.0000
Organic	1.433	2.832	0.0000	0.0000
Natural	1.082	0.715	0.0000	0.0000
Sustainable	1.173	1.690	0.0000	0.0000

Notes: Residuals from the OLS outcome equation on each selected subsample. Normality is rejected for every label (right-skewed and leptokurtic; $p < 0.001$ for both tests).

676 **Table A4: WTP outcome equation — all covariates, OLS versus Heckman two-step estimates**

	Biodynamic		Fairtrade		Organic		Natural		Sustainable	
Variable	OLS	Heckman	OLS	Heckman	OLS	Heckman	OLS	Heckman	OLS	Heckman
Age	+0.129	+0.327	-0.049	-0.067	-0.006	+0.035	+0.102	+0.885***	-0.043	+0.160
Gender	+0.422	+0.360	+0.305	+0.314	+0.295	+0.320	+0.751**	+0.448	+0.153	+0.142
Education	+0.561**	+0.591**	+0.032	+0.048	+0.050	+0.024	+0.227	+0.343*	+0.108	+0.058
Income	-0.084	-0.266	-0.073	-0.060	-0.028	-0.046	+0.089	+0.243	-0.034	-0.207
Marital	+0.185	+0.113	-0.019	-0.034	-0.086	-0.083	-0.330	-1.588***	-0.171	-0.158
HowOften	-0.620***	-0.770**	-0.073	-0.064	-0.091	-0.141	-0.210	-1.047***	-0.061	-0.132
Knowledge	-0.032	-0.089	+0.056	+0.047	+0.044	+0.049	+0.012	-0.221	+0.008	-0.009
Heard	+0.671	+0.450	-0.029	-0.072	+0.484	+0.479	-0.044	-1.218**	+0.132	-0.053
Bought	-0.487	-0.332	-0.035	+0.023	+0.119	+0.046	+0.782*	-0.619	-0.330	-0.385
Imp.	+0.426**	-0.021	+0.250**	+0.282	+0.195	+0.092	+0.026	-2.119**	+0.111	-0.488
Events_Special	+0.163	-0.164	+0.508**	+0.481	+0.246	+0.123	+0.097	-2.878**	+0.271	-0.097
Economic	+0.758	+0.379	+0.525	+0.520	+0.290	+0.328	+0.094	-0.143	+0.339	+0.579
Environment	-0.261	-0.435	+0.616*	+0.634*	+0.895**	+0.904**	+1.007*	+2.451***	+0.819*	+0.620
Social	-0.300	+0.386	-0.511	-0.540	-0.497	-0.436	-0.250	-0.725	-0.267	+0.116
λ (Mills)	—	-1.247	—	+0.181	—	-0.509	—	-7.422**	—	-1.871
p-value (λ)	—	0.603	—	0.844	—	0.660	—	0.010	—	0.318
N (selected)	75	75	144	144	145	145	87	87	116	116

677 Notes: OLS omits the selection-correction term (inverse Mills ratio, λ). Significance: *** p<0.01, ** p<0.05, * p<0.10.

678 **Table A5: WTB selection equation (probit) — listwise deletion versus Multivariate Imputation by Chained**
679 **Equations (MICE)**

	Biodynamic		Fairtrade		Organic		Natural		Sustainable	
Variable	Listwise	MICE	Listwise	MICE	Listwise	MICE	Listwise	MICE	Listwise	MICE
Age	-0.286***	-0.302***	-0.293***	-0.323***	-0.221**	-0.223**	-0.160*	-0.210**	-0.238***	-0.240***
Gender	+0.028	-0.042	+0.183	+0.143	-0.100	-0.193	+0.067	+0.064	-0.041	-0.075
Education	-0.039	+0.025	+0.214	+0.179	+0.157	+0.136	-0.019	-0.010	+0.080	+0.047
Income	+0.244	+0.230	+0.217	+0.191	+0.125	+0.097	-0.039	-0.023	+0.210	+0.186
Marital	+0.148	+0.115	-0.294	-0.281	-0.062	-0.131	+0.293	+0.343	-0.002	-0.053
HowOften	+0.190	+0.199	+0.200	+0.232	+0.275	+0.281*	+0.166	+0.203	+0.061	-0.000
Knowledge	+0.062	+0.054	-0.163*	-0.181**	-0.028	-0.052	+0.043	+0.002	+0.020	+0.024
Heard	+0.334	+0.384	-0.689**	-0.415	+0.126	+0.724*	+0.232	+0.165	+0.171	+0.119
Bought	-0.270	-0.383	+0.932***	+0.744***	+0.409	+0.372	+0.414	+0.389	+0.218	+0.436
Imp.	+0.607***	+0.646***	+0.462***	+0.443***	+0.536***	+0.561***	+0.466***	+0.452***	+0.652***	+0.672***
Events_Special	+0.440	+0.446*	-0.476	-0.371	+0.752**	+0.596*	+0.680**	+0.609**	+0.457	+0.384
Economic	+0.573	+0.718*	-0.081	+0.050	-0.183	-0.186	+0.103	+0.006	-0.248	-0.298
Environment	+0.353	+0.220	+0.329	+0.281	-0.086	-0.018	-0.357	-0.190	+0.220	+0.457
Social	-1.037**	-0.973**	-0.547	-0.537	-0.410	-0.529	+0.051	+0.076	-0.503	-0.612*
N	190	210	186	210	186	210	186	210	184	210

680 Notes: Listwise deletion uses complete cases only; MICE imputes missing covariates by chained equations (IterativeImputer,
681 BayesianRidge; m = 20 imputed datasets) on the full sample of 210 respondents; estimates are pooled across the imputed
682 datasets using Rubin's rules [53]. Significance: *** p<0.01, ** p<0.05, * p<0.10.