Analysis of Consumer Preferences and Willingness-to-Pay for Organic Food Products in Germany

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Abstract

This study employs a choice experiment approach to investigate consumers' preferences and willingness-to-pay (WTP) for organic food products. We use mixed logit and latent class models to examine preference heterogeneity. The results revealed significant heterogeneity in preferences for organic apples, milk, and beef product attributes among consumers. The WTP results obtained from mixed logit indicate gender-specific differences for the examined products of this study. Female respondents have a significant higher WTP for apple attributes, while significant higher WTP values for beef attributes are observed for male respondents. The findings of the latent class models indicate that consumers' trust tend to influence their preferences for organic food products.

Keywords Organic farming, choice experiment, preference heterogeneity, mixed logit, latent class model

JEL code C25, D12

1 Introduction

In Germany, organic production and regional products represent an increasingly significant aspect of the national agricultural sustainability strategy. In 2011, sales of organic products were estimated at 6.59 billion Euros. Although there was an increase of about 9% in that year, the market share of organic food products remains quite low (AMI 2012). Consumers are becoming increasingly aware of, and at the same time uncertain about the credence characteristics of food products. Both conventional and organic food industries have faced many food crises in the last two decades, resulting in a reduction in consumer trust and confidence in both types of food products (BMELV 2012).

Several studies have investigated food attributes for conventional food (Burton *et al.* 2001) as well as those for organic food (Enneking 2004; Sackett, Shupp, and Tonsor 2011), using stated preference approaches. Most of these studies used ordered probit or multinomial logit models to analyze preference behavior. However, these models do not account for heterogeneity of preferences among consumers, and are therefore less useful in providing policy recommendations for different organic food product attributes. Other studies (Cicia, Del Giudice, and Scarpa 2002; Gao and Schroeder 2009) that employed mixed logit models to account for preference heterogeneity did not consider whether gender-specific differences affect willingness-to-pay (WTP) for organic products. Study results have shown differences in the environmental and social behaviours of males and females (Croson and Gneezy 2009; Eckel and Grossman 2008). These studies have found a higher degree of uncertainty towards environmental and social cues among females.

The goal of this study is to integrate psychometric data in a choice experiment (CE) survey to examine preference heterogeneity among consumers and their WTP for organic food products. We consider the role of trust and gender differences in analyzing both preferences and WTP for organic products.

The CE survey was conducted between September and December 2010, using different organic food attributes. Attributes and their levels were combined according to an experimental design to create choice sets. Beside the choice sets, the questionnaire covered a variety of questions, including socio-economic characteristics and attitude items (for example trust and risk acceptances). A response rate of 46.9% was achieved, yielding a total of 1,182 useable questionnaires. Specifically, we employ a mixed logit model to analyze the existence of preference heterogeneity among consumers, differentiated between males and females. We then use a latent class model to examine the sources of heterogeneity across classes of organic food consumers.

The rest of the paper is structured as follows. The next section presents the methodology of CEs. This is followed by a description of the survey design and the data used in the analysis. The fourth section presents the empirical results. Conclusions are presented in the final section.

2 Methodology: the choice experiment approach

CEs are derived under the assumption of utility-maximizing behavior based on Lancaster's consumer approach (1966). This approach postulates that consumers are not interested in goods *per se* but in the function of attributes or characteristics shared by more than one good that give them utility.

CEs are based on the random utility model which assumes that consumers derive utility from consumption of organic food products where the latent variable U_{ni} is the nth consumer's utility of choosing alternative i and is considered to be decomposable into the observable, deterministic component of utility V_{ni} that is usually measured as a function of several explanatory variables X_{ni} and a vector of coefficients β_n, and the unobservable (random) component of utility ε_{ni}.

Given that the consumer is faced with three discrete choices in each choice set (alternative A, B or C), the probability that decision maker n chooses alternative i is equal to the probability that a sampled individual n will choose alternative i from a finite set of alternatives in choice set C_n if and only if the utility of this alternative i is associated with at least as much utility as any other alternative j within the choice set C_n (Hensher, Rose, and Greene 2005):

$$\mathrm{P}(\mathrm{i}|C_n) = P\ [(V_{ni} + \varepsilon_{ni}) \geq \left(V_{nj} + \varepsilon_{nj}\right),\ \forall\, j \in C_n = 1, \dots, J;\ i \neq j \qquad (1)$$

The choice modeling specification

Discrete choice models are usually used to model the choices made by the sampled individuals from the CE.

Mixed logit is highly flexible and can approximate any discrete-choice model derived from random utility maximization. It was developed recently as a model that is less restrictive in its behavioral assumptions than conventional logit models. It allows for taste parameters of observed parameters in the distribution, for unrestricted substitution patterns implied by the Independence of Irrelevant Attributes (IIA) property, and correlation in unobserved factors over time. The most widely used mixed logit model is based on the random utility model.

Consumer n chooses a preferred organic food product out of a set of j organic food products with different attributes and attribute levels in a given choice situation t. The emphasis in mixed logit is that the coefficients $\beta_n$vary over individuals in the population with density $f(\beta_n|\theta)$, where θ is a vector of parameters that constitutes, for example, the mean and covariance of the β's in the population. The specification is similar to the standard logit but with multivariate distributions for the random parameters. Both β_n and ε_{njt} are unobservable by the researcher. The unconditional choice probability is therefore the integral of L_{nit} (β_n) over all possible values of β_n. The integral of the probability is approximated through simulation and maximized simulated log-likelihood functions (Train 2003).

The latent class model offers an opportunity to account for the preference heterogeneity in consumer demand analysis using latent class segmentation. The concept suggests that there may be discrete segments (or classes) of consumers, not immediately identifiable from the data, that exhibit different choice behaviors. This means that consumers can be categorized into latent classes that are characterized by homogeneous tastes β but with heterogeneity existing across the different classes (Boxall and Adamowicz 2002). The latent class model is less flexible than the mixed logit model because the underlying continuous distribution is approximated with a discrete one (Train 2003). The latent classes are based on the individuals' risk acceptances and trust attitudes as well as on socio-economic and demographic characteristics. Hence, the latent class model is used to identify class membership.

In the latent class model the parameter heterogeneity is modelled by a discrete parameter variation. Consumers are implicitly sorted into a set of classes, c, but the researcher cannot observe which classes they belong to. Within a class, consumer choices from one situation to the next are assumed to be independent. The behavioural model is a logit model for discrete choices where the probability that individual n chooses the alternative that gives maximum utility among J alternatives in choice situation t, given that he/she is in class c is as follows (Greene and Hensher 2003):

$$P(nit|c) = \prod_{t=1}^{T} \frac{\exp(\beta_c' X_{nit})}{\sum_{j=1}^{J} \exp(\beta_c' X_{nit})} \qquad (2)$$

X_{nit} is a vector of observable attributes associated with alternative i, and β_c' is a class-specific parameter vector that captures heterogeneity across classes.

Since the classes are not known, class probabilities follow the conditional logit form and the variable z_n enters the model for class membership and is a set of observable characteristics (attitudinal data and socioeconomic characteristics of the consumer). For model identification the cth parameter vector is normalized to zero (Greene 2003). The latent class model makes no IIA property assumption regarding the observed probabilities (Boxall and Adamowicz 2002).

Due to the fact that the class assignment is unknown, the unconditional probability that individual n chooses alternative i in choice situation t is obtained by combining the conditional probability with the class membership probability:

$$P(i) = \sum_{c=1}^{C} \left[\frac{\exp(\theta_c z_n)}{\sum_{c=1}^{C} \exp(\theta_c z_n)} \prod_{t=1}^{T} \frac{\exp(\beta_c' X_{nit})}{\sum_{j=1}^{J} \exp(\beta_c' X_{nit})} \right] \quad (3)$$

This implies that the probability of making a particular choice is the expected value of class-specific probabilities for the sampled individual n (Greene 2007).

3 Survey Design and Data Description

The study is based on a CE survey that was conducted between September and December 2010, using three different products produced according to the guidelines of organic farming. The products included apples, milk and beef. For simple random samples, the minimum acceptable sample size for choice data is calculated by the method recommended by Hensher, Rose, and Greene (2005). In order to identify the relevant organic product attributes for the CE, business leaders and organizations were consulted. Information from the consultation was complemented with a literature review of organic food. A total of three attributes, each with three attribute levels for all three products were identified and included in the survey design. Four attributes with three attribute levels were identified separately for the organic options.

The attributes for the organic apples were the reduction of pesticide residues and higher vitamin C content. Several studies have indicated that organic farming leads to pesticide residues at a lower frequency and at a lower level than in conventional farming (Dangour *et al.* 2009; Smith-Spangler *et al.* 2012). The first level (99.9% reduction) is related to the absence of residues, the second level (95% reduction) implies traces of residues from one component (<0.01mg/kg), and the third level (35% reduction) comprises residues (>0.01mg/kg) from one or more components. Some studies have found a lower nitrate level in organic foods than in conventional foods, and a higher vitamin C content[1] (Hajšlová *et al.* 2005, Winter and Davis 2006). Vitamin C can strengthen the immune system, and therefore help prevent degenerative chronic diseases (DGE *et al.* 2000). Hence, the vitamin C content could be 5%, 25%, or 50% higher in organic apples than in the conventional counterpart.

[1] Vitamin C works in the body against the metabolic products of nitrate, nitrite or nitrosamines (Elmadfa and Leitzman 2004).

The antibiotic residue reduction and the enhanced omega-3 fatty acids were included for the organic milk options. The (preventative) use of antibiotics is prohibited in organic farming (according to the Council Regulation (EC) No 834/2007). A high level of antibiotic use is related to the development of antibiotic resistances that could be transmitted to humans through final food products and evoke various diseases (Phillips *et al.* 2004). Some studies have found a lower level of residues in organically produced milk and meat, compared to conventionally produced milk and meat (Smith-Spangler *et al.* 2012). Therefore, the antibiotic residues in organic milk could be 50%, 75% or 99.9% lower than in conventionally produced milk. Omega-3 fatty acids (also called ω−3 fatty acids) are essential fatty acids. When combined with a healthy diet, polyunsaturated omega-3 fatty acids offer good protection for the heart and the circulation (Elmadfa and Leitzman 2004). Several studies show that organic milk contains more omega-3 fatty acids than conventional milk due to the husbandry and feeding practices (Molkentin and Giesemann 2007). Due to seasonal variations, the content of omega-3 fatty acids could be 5%, 15% or 30% higher in organic milk and beef compared to their conventional counterparts.

The feed used in organic farming need not necessarily be generated on the farm in question (in the case of the organic Council Regulation (EC) No 834/2007). Due to an increasing demand for organic meat, regional protein feeds are being replaced by cheap imported organic protein feeds. However, many associations require their members to use at least 50% feed from their own organic farm, so as to ensure a closed nutritional cycle. In the following analysis, the organic feed is either *100% organic farm-grown feed*, *100% organic feed of which 50% is purchased organic feed*, or *95% organic feed, 5% conventional feed.*

The demand for local food has risen greatly, in addition to the increase in the organic food market (Darby *et al.* 2008). In this study, the organic apples and beef are from either the local region, from Germany, or from the European Union. In the case of organic milk, the three regions are the local region, the state, or Germany.

The different price levels were based on real consumer prices in Germany in 2009 (AMI 2010). The price and the local region were considered for all three products. The attributes and attribute levels are presented in Table 1.

Table 1 Attributes and attribute levels used in the CE survey

	Organic apples	Organic milk	Organic beef
Pesticide residues	99.9% less; 95% less; 35% less	-	-
Antibiotic residues	-	99.9% less; 95% less; 75% less	-
Vitamin C	50% more; 25% more; 5% more	-	-
Omega-3 fatty acids	-	30% more; 15% more; 5% more	30% more; 15% more; 5% more
Feed	-	-	100% organic farm-grown feed; 100% organic feed, of which 50% is purchased organic feed; 95% organic feed; 5% conventional feed
Region	Local region; Germany; European Union	Local region; state; Germany	Local region; Germany; European Union
Price	2.39€/kg; 2.49€/kg; 2.59€/kg	0.89€/l; 0.99€/l; 1.09€/l	4.99€/500g; 5.99€/500g; 6.99€/500g

Source: author's own presentation.

Attributes and their levels were combined according to an experimental design to create choice sets. The large number of choice sets (3^4=81) for each product, in a full factorial design in which all possible treatment combinations are enumerated, leads to an orthogonal main effects only design, combined with a blocking strategy that ensures seven choice sets for each product. Each choice set offered the respondent three alternatives: the first two alternatives were organic options, while the third alternative presented the conventional, non-organic option at the base price.

The introduction of the CE included general information about organic foods and the attributes used in the choice sets. Respondents were then requested to choose the alternative in each choice set that they would like to purchase.

Beside the choice sets, the survey included a variety of questions, including socio-economic characteristics and individuals' satisfaction and risk acceptances towards general statements and in specific categories (work, education, free time and health). Moreover, statements on trust in personal networks, trust in political and economic systems, and trust in strangers are presented, with different attitude items. The expertise of the participants is also analysed. Furthermore, attitude statements about organic food products are included.

A preliminary pilot study was conducted with a small sample of individuals (n=50) to test the questionnaire. A total of 2520 questionnaires were originally mailed to households. However, a response rate of 46.9% was achieved, yielding a total of 1,182 useable questionnaires. The addresses of potential respondents for the survey were obtained from an agency (Schober Information Group). These randomly selected addresses were drawn from a pool of respondents from the last lifestyle consumer survey conducted by that agency.

Table 2 presents sample statistics of the respondents. Overall, the sample constitutes a good representation of the German population. The average of respondents was 46.6, which compares well with the national average age of 44 in 2010 (Statistisches Bundesamt 2010). In terms of gender, females represented 54% of the respondents. Females are the primary food shoppers in most households and are therefore responsible for the food choices. Hence, the proportion of females in this food related survey is slightly above the national proportion of females (51%) (Statistisches Bundesamt 2010).

Table 2 Descriptive statistics

	Mean	Std. Dev.
Female	0.54	0.49
Age	46.6	12.67
Per capita income/month(€)	1069.92	625.39
Education		
No education	0.00	0.06
Elementary and Secondary School	0.14	0.39
A-level	0.13	0.35
Professional education	0.42	0.49
University degree (incl. PhD.)	0.22	0.41

Source: author's own presentation.

4 Empirical Results

The mixed logit and latent class models were estimated using NLOGIT software version 4.0 (Econometric Software, Inc. 2007). The estimates from the mixed logit model are first presented, followed by those from the latent class model.

4.1 Mixed logit model

The simulated maximum likelihood estimates for mixed logit, that allows for correlated random parameters using 100 Halton draws, for all three products are reported in Table 3. The IIA test procedure developed by Hausman and McFadden (1984) has shown violations for the conditional model for apples, milk, and beef at the level of 1%.[2] Mixed logit allows for unrestricted substitution pattern implied by the IIA property (Train 2003). A likelihood ratio (LR) test and a zero-based (asymptotic) *t*-test for standard deviations are used to calculate the set of random parameters, as described by Hensher, Rose, and Greene (2005). It is further

[2] For instance, the Hausman test statistic (alternative 1 dropped) for apple in the pooled sample A (B) is 95.72 (55.80) and is significant at the level of 1%. The Hausman test statistics for alternative 2 and for milk and beef are not illustrated in the interest of brevity, but are available upon request.

assumed that the random parameters are drawn from a multivariate normal distribution, except for the purchase price which is assumed to have a triangular distribution. The mixed logit model estimates a conditional logit to derive initial start values for each of the parameters. The relative performance can be compared by using a LR test. The results show that the mixed logit model with random taste variations fits the data better than the fixed parameters in the conditional logit model. The LRs decreases for apple (as well as milk and beef) and the LR tests reject the null hypothesis that the conditional logit model fits the data better than the mixed logit for all products.

The estimates presented in Table 3 indicate that the mean coefficients for apple, milk, and beef attributes are significantly different from zero at the level of 1% (except pesticide residue reduction and organic farm-grown feed at the level of 10%). Model 1 indicates that consumers show high preferences for locally produced apples, with low pesticide residues, higher vitamin C levels, as well as lower prices. The non-random parameters, a 95% reduction of pesticide residues and the region Germany, are positive and statistically significant, implying that respondents preferred products with low pesticide content, as well as those produced in Germany. The constant parameter represents the conventional option and is negative and statistically significant, indicating a preference for organic apples. For milk and beef products, it is observed that consumers prefer organic products with higher omega-3 fatty acids content, those produced in the region, and sold at lower prices (model 2 and 3). There is statistically significant preference for lower antibiotic residues in organic milk and a quite low, but significant preference for the 100% organic farm-grown feed with regard to organic beef products. The magnitude of the estimated parameters suggest that origin of the product is more important than all other attributes considered by the respondents. This is probably because consumers' preferences for local products are based on sustainability items that include protection of the local environment.

The derived standard deviations of the random parameters calculated over 100 Halton draws represent the amount of spread that exists around the sample population (Hensher, Rose, and Greene 2005). The standard deviations of all random parameters are significant at the level of 1%, indicating preference heterogeneity in the population.

The standard deviations of random parameters may be correlated with other random parameters, and as such may not be independent. To analyze the independent random parameter estimates, the Cholesky decomposition matrix unconfounds the correlation structure over the random parameters. Significant below-diagonal elements would suggest significant cross-parameter correlations. This would imply that most of the random parameters were actually independently heterogeneous in the population (Hensher, Rose, and Greene 2005). The magnitudes of the diagonal value parameters are much lower than their reported standard deviations. Due to the fact that they are confounded with other parameters, these values represent the true variance related to that attribute. For example, the diagonal value for attribute 3 for apples (vitamin C) is not statistically significant, but the standard deviation is significant. The below-diagonal values in the Cholesky matrix reveal that the significant standard deviation resulted from the significant cross-correlations with other organic attributes (for example attribute 2 for apples: pesticide residue reduction).

Interaction terms formed by relating the random parameters (price) to other covariates (trust) in effect decompose any heterogeneity observed within the price parameter, thus providing an explanation for the heterogeneity. Significant interaction term results suggest that differences in the marginal utilities for the random parameter price can be explained by differences in personal trust levels (Hensher, Rose, and Greene 2005). The heterogeneity in the mean parameter estimate for the price and trust variables implies that the sensitivity to prices related to trust decreases as the trust level increases, *ceteris paribus*. Hence, individuals with a higher trust characteristic are less price-sensitive because their marginal utilities are further from zero. The price parameters of individuals with a lower trust level are closer to zero, suggesting a higher price-sensitivity.

Table 3 Simulated maximum likelihood estimates from mixed logit

	Apples (1)	Milk (2)	Beef (3)
Random parameters in utility functions			
Purchase price (€)	-9.0561*** (2.4169)	-5.6811*** (1.0217)	-0.7525*** (0.0677)
Attribute 2[a]	0.4489** (0.1893)	0.3193*** (0.0747)	0.0836** (0.0359)
Attribute 3[b]	0.8005*** (0.1936)	0.3157*** (0.0606)	0.1833*** (0.0348)
Local region	1.6814*** (0.3936)	0.4477*** (0.0828)	0.6082*** (0.0518)
Non-random parameters in utility functions			
Attribute 4[c]	0.6172*** (0.1252)	0.2056*** (0.0542)	-
Attribute 5[d]	0.4068*** (0.1123)	0.0989 (0.067)	0.2044*** (0.0379)
Constant	-9.8279*** (2.7272)	-1.1734*** (0.3493)	-0.7648*** (0.0965)
Heterogeneity in mean, Parameter: Variable			
Purchase price (€): trustful	3.0352*** (0.8687)	3.1031*** (0.5015)	0.3788*** (0.056)
Purchase price (€): rather trustful	3.2459*** (0.9041)	2.3387*** (0.4233)	0.408*** (0.0522)
Purchase price (€): rather distrustful	1.8482*** (0.5703)	2.2986*** (0.4229)	0.3483*** (0.0514)
Diagonal values in Cholesky matrix, L			
Ts Purchase price (€)	18.5096*** (4.9415)	18.4472*** (2.6605)	1.7843*** (0.1851)
Ns Attribute 2[a]	1.2301** (0.4794)	0.4744*** (0.1713)	0.3986 (0.2605)
Ns Attribute 3[b]	0.602 (0.5003)	0.4148 (0.3566)	0.0383 (0.7484)
Ns Local region	1.7048*** (0.5223)	0.5381 (0.6596)	0.023 (0.8109)
Below diagonal values in L matrix. V=L*Lt			
Attribute 2[a]: purchase price (€)	-3.8034*** (0.8763)	3.5354*** (0.5353)	-0.6269*** (0.2222)
Attribute 3[b]: purchase price (€)	-1.1323 (0.7533)	0.5787 (0.3969)	-0.8456*** (0.2768)
Attribute 3[b]: attribute 2[a]	-0.7167*** (0.2345)	-0.4537* (0.2275)	0.1146 (0.2209)
Local region: purchase price (€)	-1.7053** (0.8143)	0.6805 (0.4848)	-1.6281*** (0.3049)
Local region: attribute 2[a]	0.1143 (0.3332)	-1.3923*** (0.3408)	0.1881 (0.2421)
Local region: attribute 3[b]	0.8058 (0.5063)	0.2613 (0.6612)	0.0975 (0.8001)
Standard deviations of parameter distributions			
Purchase price (€)	18.5096*** (4.9415)	18.4472*** (2.6605)	1.7843*** (0.1851)
Attribute 2[a]	3.9974*** (0.9154)	3.5671*** (0.5388)	0.7429*** (0.2257)
Attribute 3[b]	1.4691** (0.6278)	0.8443** (0.36)	0.8542*** (0.2816)
Local region	2.545*** (0.6028)	1.6611*** (0.5027)	1.642*** (0.3018)
Log likelihood at start values (MNL)	-8570.274	-8549.401	-8508.752
Simulated log likelihood at convergence	-7683.006	-8054.612	-7953.003
LR test *($X^2_{0.99}(26)=54.05$)*	1774.5	989.6	1111.5
McFadden R^2	0.1	0.06	0.07
Halton Draws	100	100	100
Number of observations	7801	7782	7745

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

[a]Attribute 2: A1: Pesticide residue reduction of 99.9%; M2: Antibiotic residue reduction of 99.9%; B3: 100% organic farm-grown feed

[b]Attribute 3: A1: Vitamin C increase of 50%; M2, B3: Omega-3 fatty acids increase of 30%

[c]Attribute 4: A1: Pesticide residue reduction of 95%; M2: Omega-3 fatty acids increase of 75%

[d]Attribute 5: A1, B3: From Germany; M2: From the state

Source: author's own presentation.

WTP estimates obtained from Mixed Logit

WTP estimates are the derivation of the marginal rate of substitution between significant attributes and significant purchase prices. Constraining the distribution, for example the spread of the distribution to the mean, from which the random parameters are drawn derives behaviorally meaningful WTP values from the mixed logit (Hensher and Greene 2003). Hence, it is possible to use conditional constrained random parameters.[3] Negative WTP estimates are allowed in order to measure negative preferences related to disutility. Given our interest in gender-specific WTP estimates, we compared WTP for males and females. These estimates are presented in Table 4.

The results indicate that both male and female respondents do exhibit a positive WTP (0.02 Euros - 0.23 Euros) for all organic apple attributes. On the other hand, they both show a negative WTP (-1.50 Euros and -1.35 Euros) for conventional apples.

The results also indicate a positive WTP for organic milk attributes. In particular, females are willing to pay 0.35 Euros more for a higher omega-3 fatty acids content, 0.58 Euros more for milk from their region, and 0.56 Euros more for the reduction of antibiotic residues. Male respondents have a higher WTP for these attributes (0.58 Euros more for omega-3 fatty acids and local milk, and 0.98 Euros more for the antibiotic residue reduction). Furthermore, while female respondents have a negative WTP for the conventional option (-0.12 Euros), male respondents show a positive WTP for conventional milk (1.14 Euros).

Regarding the results for beef products (Table 4), females have a positive WTP for organic beef attributes (0.30 Euros more for 100% organic farm-grown feed, 0.49 Euros more for omega-3 fatty acids, and 1.84 Euros more for beef from the local region). Males have higher WTPs for the attributes omega-3 fatty acids (0.61 Euros) and the local region (2.20 Euros). However, females valued a higher WTP for organic product to avoid the conventional beef than males (2.34 Euros vs. 0.88 Euros).

Given different scale parameters in the choice models, the parameters cannot be compared directly in both samples. A direct comparison between the WTP estimates can be made by cancelling out the scale parameter (Train 2003).

[3] This means that common choice-specific parameter estimates are conditioned on the choices that are observed to have been made by an individual.

Table 4 Comparison of estimates obtained from mixed logit (apples, milk, and beef)

	Female Estimates	WTP	**Male** Estimates	WTP	ΔWTP (t-test)[a]	ΔWTP (CC)[b]
Apples						
Random parameters in utility functions						
Purchase price (€)	-12.8759*** (4.3435)		-10.362*** (3.4158)			
Pesticide residue reduction of 99.9%	1.2655*** (0.4211)	0.14	1.1077*** (0.3507)	0.14	-0.01***	-0.01*
Vitamin C increase of 25%	1.0422*** (0.3473)	0.11	0.842*** (0.2725)	0.11	0	0*
Local region	2.1217*** (0.6737)	0.23	1.5018*** (0.4428)	0.19	0.03***	0.03*
Non-random parameters in utility functions						
Pesticide residue reduction of 95%	0.6724*** (0.1992)	0.07	0.2958*** (0.104)	0.04	0.03***	0.03*
From Germany	0.2464** (0.1151)	0.03	0.1413 (3.5904)	0.02		
Constant	-14.001*** (4.8169)	-1.50	-10.649*** (3.5904)	-1.35	-0.15***	-0.15
Milk						
Random parameters in utility functions						
Purchase price (€)	-2.2103*** (0.4891)		-1.0522** (0.4986)			
Antibiotic residue reduction 99.9%	0.335*** (0.0494)	0.56	0.3199*** (0.0483)	0.98	-0.42***	-0.42
Omega-3 fatty acids increase of 30%	0.2045*** (0.0368)	0.35	0.1911*** (0.0371)	0.58	-0.23***	-0.23
Local region	0.322*** (0.0468)	0.58	0.1868*** (0.0475)	0.58	0	0
Non-random parameters in utility functions						
Antibiotic residue reduction of 75%	0.3111*** (0.0557)	0.50	0.1811*** (0.0533)	0.55	-0.05***	-0.05
From the state	0.0724 (0.0486)	0.12	0.1147*** (0.1909)	0.35		
Constant	-0.074 (0.1937)	-0.12	0.3748** (0.1909)	1.14		

Table 4 *(continued)*

	Female Estimates	WTP	Male Estimates	WTP	ΔWTP (t-test)[a]	ΔWTP (CC)[b]
Beef						
Random parameters in utility functions						
Purchase price (€)	-0.6455***		-0.4855***			
	(0.0632)		(0.0649)			
100% organic farm-grown	0.0878**	0.30	0.0491	0.20		
feed	(0.0372)		(0.0391)			
Omega-3 fatty acids	0.1576***	0.49	0.1538***	0.61	-0.12***	-0.12***
increase of 30%	(0.0333)		(0.0361)			
Local region	0.616***	1.84	0.5547***	2.20	-0.36***	-0.36***
	(0.0461)		(0.0488)			
Non-random parameters in utility functions						
From Germany	0.1721***	0.53	0.2062***	0.81	-0.28***	-0.28***
	(0.0369)		(0.0394)			
Constant	-0.757***	-2.34	-0.223**	-0.88	-1.45***	-1.45
	(0.0941)		(0.097)			

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1
[a] ΔWTP denotes a *t*-test for equality of mean for the two WTP measures.
[b] ΔWTP denotes a complete combinatorial (CC) method for overlapping of two WTP distributions (Poe, Giraud, and Loomis 2005).
The model specification (number of observations, (un)restricted maximum LLs, Pseudo-R^2-adjusted) are not reported in the interest of brevity, but are available upon request.
Source: author's own presentation.

Differences in WTP

The numerical differences presented in the two right columns of Table 4 suggest that male respondents have a higher WTP for milk and beef attributes and a lower WTP for apple attributes. An analysis of the WTP differences for all three products indicates that female respondents have a higher WTP for apples, while male respondents have a higher WTP for milk and beef attributes. In addition, females are willing to pay a higher price premium to avoid the conventional alternatives for all three products than males.

Some studies have used the *t*-test to examine the equality of the mean WTP values for males and females. If the null hypothesis of identical WTPs for males and females is rejected, the presence of gender-specific differences would be established. For example, Ladenburg and Olsen (2008) found a significant gender-specific effect in the case of starting point bias by employing *t*-tests that are based on the normality assumption. However, Poe, Giraud, and Loomis (2005) point out that a complete combinatorial (CC) approach is a non-parametric test which provides an exact and unbiased measure for the differences in WTP estimates between the two independent samples. This test uses for the calculations every possible difference in WTP between the two samples. The advantage of the CC method is that it is less restrictive than a *t*-test due to the absence of symmetric distributions of WTP measures that lead to the normality assumption and the nonoverlapping confidence interval criterion (Poe, Severance-Lossin, and Welsh 1994; Poe, Giraud, and Loomis 2005). Other studies used the CC procedure to estimate the significance differences of two distributions by analyzing a hypothetical bias or an embedding effect (Lusk and Schroeder 2004; Mørbak *et al.* 2011).

Both the *t*-test and the CC method are employed in this study. The results of the *t*-test in the sixth column indicate that, for all three products, there are significant differences in the WTP values between the two samples: the null hypothesis of equal WTP could be rejected in nearly all cases at the 1% level (except for vitamin C increase for apples and local produced milk). The CC test results for all three products are presented in the seventh column of Table 4. The results also suggest that the WTP estimates of males and females are not equivalent for apple and beef attributes.

Hence, the WTP for males and females are significantly different. In the case of male respondents all apple attributes are valued significantly lower at the 5% level. While significant lower WTP values for beef attributes are observed for female respondents. Moreover, the differences in the WTP for the conventional options for all products and the differences in the WTP for the organic milk attributes show significant differences by the *t*-test and no significant differences by the CC test. Hence, the *t*-test may result in biased estimates and incorrect statistical tests of the difference of empirical distributions due to the restrictive assumption about normality (Poe *et al.* 1994; Poe, Giraud, and Loomis 2005).

In general, the WTP results indicate significant gender-specific differences for apple and beef product attributes of this study. This observation is consistent with that of Ureña, Bernabéu, and Olmeda (2008) who found depending on the type of organic food significant differences in WTP between males and females. The findings are also in line with other studies that show differences in preferences between males and females (Eckel and Grossman 2008; Croson and Gneezy 2009).

4.2 Latent class model

The Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) are used to identify the optimal number of latent classes as recommended by Boxall and Adamowicz (2002). The AIC and BIC had the lowest values in the three class model for milk and beef.[4] For class identification, a three-class model was used for all three products. The maximum likelihood estimates for the latent class model for all three products are presented in Tables 5, 6, and 7. The differences in the magnitudes and significances of the utility function parameter estimates indicate significant heterogeneity in preferences across latent classes. For example, the apple attribute produced in Germany suggests for class 1 a strongly negative preference for this option, while the coefficient was strongly positive for class 2. The class membership coefficients for the third class have been normalized to zero in order to identify the remaining coefficients of the model. The class membership coefficients for apple, milk, and beef consumers indicate that the probability of being in a particular class is significantly related to trust factors (trust in personal networks, trust in political and economic systems and trust in strangers).

Table 5 indicates that 31% of the respondents for apples have a high probability of belonging to class 1, 48% to class 2, and 20% to class 3. The estimates for apples reveal that consumers in latent class 1 preferred apples that are cheap (price-sensitive), have a 99.9% lower pesticide residue content, enhanced vitamin C and are produced locally. The class is also associated with a significant and positive value for personal health risk acceptances of credence attributes and for distrust. Hence, these consumers might be rather conservative and skeptical towards organic food. Members of class 2 have trust in organic food production because the class membership coefficients indicate a positive, albeit statistically insignificant coefficient. They prefer locally produced apples with low pesticide residues and higher vitamin C content. Moreover, the consumers have a high and significant probability of choosing the organic alternative. Consumers in class 3 prefer organic apples produced locally, enhanced vitamin C, and less pesticide residues. This class may be associated with rather indifferent (organic) consumers.

[4] The BIC values are 5663 (5406, 6413) for two classes and 5143 (5012, 6305) for three classes for milk (beef, apple). The AIC values are 11200 (10686, 12700) for two classes and 10075 (9814, 12399) for three classes for milk (beef, apple).

Table 5 Maximum likelihood estimates of apple attributes obtained from latent class model

	Class 1	Class 2	Class 3
Utility function coefficients			
Purchase price (€)	-3.1082*** (1.0118)	-1.8318*** (0.292)	-1.3326*** (0.3945)
Pesticide residue reduction of 99.9%	0.9378*** (0.1144)	0.8349*** (0.0303)	0.1005** (0.0412)
Vitamin C increase of 50%	0.1768* (0.0967)	0.5453*** (0.0253)	0.2068*** (0.0372)
Local region	0.5689*** (0.1064)	0.9432*** (0.0315)	0.7637*** (0.043)
From Germany	-0.1691 (0.1041)	0.147*** (0.026)	0.0255 (0.0452)
Constant	-0.6095 (1.1945)	-4.8426*** (0.3592)	-1.414*** (0.4762)
Class membership coefficients			
Constant	0.563*** (0.1194)	0.8772*** (0.1387)	
Trustful	-0.2314 (0.1844)	0.0224 (0.1798)	
Rather trustful	-0.1755 (0.1703)	0.1072 (0.1626)	
Distrustful	0.4072** (0.184)	-0.13 (0.1867)	
Credence attribute risks	0.4225*** (0.0711)	0.0007* (0.0004)	
Female	0.0012** (0.0005)	0.1722 (0.1344)	
Number of observations	2531.144	3952.858	1643.6
Latent class probability	0.308	0.481	0.2
Log likelihood	-6169.582		
Number of groups	1182		
LL ratio test *($X^2_{0.99}(30)=59.70$)*	4322.422		

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1
Source: author’s own presentation.

Table 6 indicates that 33.5% of the respondents for milk have a high probability of belonging to class 1, 46% to class 2, and 17% to class 3. The estimates for milk reveal that consumers in latent class 1 prefer milk with a low antibiotic residue content and products produced locally. The distrust coefficient is positive and significant. These consumers might be rather conservative and skeptical towards organic food, as indicated by the positive and significant coefficient for conventional milk. Class 2 members appear to trust organic food. This is shown by the positive and significant trust coefficient. They prefer organic milk with a lower antibiotic residue, enhanced omega-3 fatty acids, and products that are produced locally. Members of class 3 prefer organic and cheap products with a low use of antibiotics, a higher level of omega-3 fatty acids, and products produced in the state. This class may consist of rather indifferent organic food consumers.

Table 6 Maximum likelihood estimates of milk attributes obtained from latent class model

	Class 1	Class 2	Class 3
Utility function coefficients			
Purchase price (€)	-2.8178 (2.0364)	-0.9926*** (0.2763)	-5.6928*** (0.4514)
Antibiotic residue reduction of 99.9%	1.2897*** (0.3443)	0.834*** (0.0263)	0.4295*** (0.0443)
Omega-3 fatty acids increase of 30%	-0.5678** (0.2663)	0.3519*** (0.0214)	0.229*** (0.0402)
Local region	0.6772*** (0.2513)	0.505*** (0.0279)	0.0699 (0.0498)
From the federal state	-0.6057* (0.3129)	0.1006*** (0.0251)	0.141*** (0.0463)
Constant	4.5709*** (0.8659)	-4.4558*** (0.1839)	-1.937*** (0.1801)
Class membership coefficients			
Constant	1.2907*** (0.1645)	1.7145*** (0.1651)	
Trustful	0.0618 (0.186)	0.3042* (0.1748)	
Rather trustful	-0.117 (0.1572)	-0.1887 (0.1502)	
Distrustful	0.4192** (0.1765)	-0.1145 (0.175)	
Food risks	-0.0003 (0.0005)	-0.0003 (0.0005)	
Young people	-0.9619*** (0.1988)	-1.1292*** (0.194)	
Number of observations	2749.01	3807.584	1403.226
Latent class probability	0.335	0.464	0.171
Log likelihood	-5007.935		
Number of groups	1182		
LL ratio test *($X^2_{0.99}(30)=59.70$)*	7337.1		

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Source: author's own presentation.

Table 7 indicates that 25% of the respondents for beef have a high probability of belonging to class 1, 52% to class 2, and 16% to class 3. The estimates for beef reveal that consumers in latent class 1 have preferences for beef products from cattle raised with 100% organic farm-grown feed, for beef with enhanced omega-3 fatty acids, and for beef that is locally produced. However, the results also suggest a high and significant probability of choosing the conventional product. Class 1 is also associated with a significant and positive value for personal health risk acceptances of credence attributes at the 1% level. These consumers might be rather conservative and skeptical towards organic food. As previously determined, members of class 2 tend to trust organic food products. They have preferences for beef raised from organic farm-grown feed, enhanced omega-3 fatty acids, and products that are produced locally or produced in Germany. Consumers in class 3 prefer the organic option and locally produced beef products. Class 3 appears to be consumers who are rather indifferent towards their preferences for organic food products.

Table 7 Maximum likelihood estimates of beef attributes obtained from latent class model

	Class 1	Class 2	Class 3
Utility function coefficients			
Purchase price (€)	-1.5051** (0.7438)	-0.1961*** (0.024)	-1.4597*** (0.0602)
100% organic farm-grown feed	1.4186* (0.8448)	0.2362*** (0.026)	-0.1985*** (0.0556)
Omega-3 fatty acids increase of 30%	0.7302 (0.5706)	0.321*** (0.022)	0.0047 (0.0499)
Local region	1.0142* (0.5192)	0.833***(0.0276)	0.4474*** (0.0629)
From Germany	0.7618 (0.4764)	0.2165*** (0.0245)	0.1427** (0.0566)
Constant	3.6679*** (0.9989)	-3.7679*** (0.0969)	-1.6349*** (0.1103)
Class membership coefficients			
Constant	0.5387*** (0.1637)	1.2851*** (0.1038)	
Trustful	-0.0269 (0.2637)	0.2007 (0.1743)	
Rather trustful	-0.0431 (0.2324)	0.1343 (0.1555)	
Distrustful	0.4186* (0.238)	-0.3341* (0.1722)	
Credence attribute risks	0.339** (0.1132)	-0.1178 (0.0949)	
Food risks	-0.0248 (0.1121)	0.1184 (0.0949)	
Number of observations	2021.944	4255.866	1288.174
Latent class probability	0.248	0.522	0.158
Log likelihood	-4876.854		
Number of groups	1182		
LL ratio test ($X^2_{0.99}(30)=59.70$)	7216.918		

Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1
Source: author's own presentation.

Class-Specific Implicit Prices of Consumers (€)

Implicit prices of the traits are presented in Table 8. The results tend to show marked differences in preference structure.

According to the results, consumers in class 1 attach low value to organic product attributes. This is not totally unexpected since conservative and skeptical consumers, the most likely members of this class, tend to consider organic products with these attributes as new products, and typically they do not trust unknown products.

Consumers in class 2 associate positive and significant values (0.10 Euros - 4.25 Euros price premium) to all attributes, especially those connected with the beef products. This can be explained by the fact that trusting organic buyers are not uncertain about the credibility of the attributes. They are willing to pay price premiums of 2.64 Euros, 4.49 Euros, and 19.22 Euros in order to avoid conventional apples, milk, and beef products, respectively.

Consumers in class 3 attach medium WTP values (0.02 Euros - 0.57 Euros price premium) to all three products because they are unsure (indifferent) about the organic product attributes and their WTP for them. They are willing to pay a price premium of 1.06 Euros, 0.34 Euros, and 1.12 Euros in order to avoid apples, milk, and conventional beef products, respectively.

Table 8 Class-specific implicit prices of organic traits (€)

Attribute	Class 1	Class 2	Class 3
Apples			
Pesticide residue reduction of 99.9%	0.30 [0.11 -- 0.49]	0.46 [0.32 -- 0.59]	0.08 [0.01 -- 0.14]
Vitamin C increase of 50%	0.06 [-0.01 -- 0.12]	0.30 [0.21 -- 0.38]	0.16 [0.06 -- 0.25]
Local region	0.18 [0.07 -- 0.3]	0.51 [0.37 -- 0.66]	0.57 [0.26 -- 0.88]
From Germany	NS	0.08 [0.04 -- 0.12]	NS
Constant	NS	-2.64 [-3.1 -- -2.19]	-1.06 [-1.16 -- -0.96]
Milk			
Antibiotic residue reduction of 99.9%	NS	0.84 [0.41--1.27]	0.08 [0.06 -- 0.09]
Omega-3 fatty acids increase of 30%	NS	0.35 [0.17--0.54]	0.04 [0.03 -- 0.05]
Local region	NS	0.51 [0.25--0.76]	NS
From the state	NS	0.10 [0.02--0.18]	0.02 [0.01 -- 0.04]
Constant	NS	-4.49 [-6.73-- -2.25]	-0.34 [-0.36 -- -0.32]
Beef			
100% organic farm-grown feed	0.94 [-0.18 -- 2.06]	1.20 [0.93 -- 1.48]	-0.14 [-0.21 -- -0.06]
Omega-3 fatty acids increase of 30%	NS	1.64 [1.27 -- 2.01]	NS
Local region	NS	4.25 [3.35 -- 5.15]	0.31 [0.23 -- 0.38]
From Germany	NS	1.10 [0.69 -- 1.52]	0.10 [0.02 -- 0.18]
Constant	NS	-19.22 [-23.38 -- -15.05]	-1.12 [-1.19 -- -1.05]

95% confidence intervals in parentheses; *** p<0.01, ** p<0.05, * p<0.1; NS (not statistically significant)
Source: author's own presentation.

The findings of the latent class models generally indicate that preference heterogeneity is related to consumer trust. The conservative and skeptical consumers are significantly more price-sensitive and prefer the attribute pesticide residue reduction in the case of apple products, antibiotic residue reduction in the case of milk products, and organic feed in the case of beef products. Moreover, for all products, they appear to prefer those produced locally, as well as conventional milk and beef products. Class 1 members view the attributes as imperfect substitutes, have the lowest trust levels, and are most concerned about the credibility of the attributes. Class 2 members have high WTP estimates because they trust in the key benefits of organic attributes (promotion of sustainable development, improvement of human health and animal husbandry). Moreover, they prefer regional products with less pesticide and antibiotic residues as well as higher contents of vitamin C and omega-3 fatty acids. However, the rather indifferent consumers (class 3) are unsure about their true preferences and have a medium WTP for organic attributes. They are significantly more price-sensitive than the other consumer groups.

5 Conclusions

This study used mixed logit and latent class models to analyze consumers' preferences for organic food products in Germany. The results revealed significant heterogeneity in preferences for the examined products among consumers. In particular, consumers showed high preferences for locally produced apples, with low pesticide residues, higher vitamin C levels, as well as lower prices. For milk and beef products, it was observed that consumers preferred organic products with higher contents of omega-3 fatty acids, those produced locally, with lower antibiotic residues, and sold at lower prices. The WTP estimates obtained from the mixed logit model indicate gender-specific differences for apple and beef product attributes. Female respondents were found to exhibit a higher WTP for apple attributes (pesticide residue reduction, vitamin C increase, and local production), while higher WTP values for beef attributes (omega-3 fatty acids, and local production) were observed for male respondents. The findings of the latent class model clearly indicate that a high level of consumer trust tends to exert a positive influence on organic food consumption, while a lower level of consumer trust has a negative effect.

The findings of this study summarized above indicate some useful information for producers of organic food, who could make good use of consumer segmentation, and for policy-makers trying to understand consumers' trust in credence goods.

Some consumer groups are willing to pay high price premiums for specific organic food products, and to some extent for locally produced food. Given that there is consumer segmentation based on varying levels of trust, organic marketing should increase its use of suitable communication strategies about quality attributes. Due to the heterogeneous preferences of the consumers, target-oriented communications about the price-to-performance ratios of various organic food attributes that add value could be one possible solution for addressing the price-sensitiveness of some consumer groups.

Due to the gender differences between the products, there is a need to adopt communication strategies that integrate product-relevant information. Product-specific information about organic food attributes may offer a second way of differentiating these products from conventional ones and therefore improving the perceived utility of organic food products.

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