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ANALYSIS OF CONSUMER PREFERENCES AND WILLINGNESS-TO-PAY FOR ORGANIC FOOD PRODUCTS IN GERMANY

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Abstract

This paper analyses consumers' preferences and willingness-to-pay for organic food products using choice experiments. We use mixed logit models to account for consumer heterogeneity in preferences. The empirical results indicate that significant preference heterogeneity exists for organic apple, milk, and beef product attributes among German consumers. The willingness-to-pay results obtained from mixed logit indicate that female respondents have higher willingness-to-pays for apple attributes, while male respondents are willing to pay more for milk and beef attributes.

Keywords

Organic farming, choice experiment, consumer preferences, mixed logit

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, 2003; SACKETT et al., 2012), using stated preference approaches. Most of these studies used multinomial or conditional logit models to analyse preference behaviour. 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 et al., 2002; GAO and SCHROEDER, 2009) that employed mixed logit models to account for preference heterogeneity failed to examine whether willingness-to-pay estimates are affected by gender-specific differences.

The main goal of this study is to examine preference heterogeneity among consumers, and their willingness-to-pay for organic food products. In particular, we consider gender differences in analysing both preferences and willingness-to-pay for organic products. It uses a stated choice modelling approach for the economic values for organic food product attributes. Specifically, a mixed logit model is employed to investigate the existence of preference heterogeneity. Given the increase in organic food consumption, it is important that a better understanding of consumers' preferences for organic food products is achieved. This can then provide the basis for analysis of implications for future developments in organic food production.

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2 Methodology: the choice experiment approach

Choice experiments are 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.

Moreover, choice experiments are based on the random utility model which assumes that consumers derive utility from consumption of organic food products as shown in equation 1:

$$U_{ni}=V_{ni}+ \varepsilon_{ni}, \quad (1)$$

where U_{ni} is the nth consumer's utility of choosing alternative i. V_{ni} is the observable, deterministic component of utility. It is usually measured as a function of several explanatory variables $V(X_{ni}, \beta)$, for example by regional attribute levels for alternative i. The unobservable component of utility is given by the random term 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 et al., 2005):

$$\mathrm{P(i|}C_n) = P\left[(V_{ni} + \varepsilon_{ni}) \geq \left(V_{nj} + \varepsilon_{nj}\right), \forall j \in C_n = 1, \dots, J;\ i \neq j\right. \quad (2)$$

The choice modelling specification

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

Mixed logit is highly flexible and can approximate any discrete-choice model derived from random utility maximisation. It was developed recently as a model that is less restrictive in its behavioural assumptions than conventional logit models. It allows for observed taste parameters in the distribution, for unrestricted substitution patterns implied by the Independence of Irrelevant Alternatives property, and for correlation in unobserved factors over time (TRAIN, 2003). 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. A constant number of choice situations per individual and a linear utility function are assumed.

3 Survey Design and Data Description

The survey data was conducted between September and December 2010, using organic apples, milk and beef. For simple random samples, the minimum acceptable sample size for choice data is determined by the method recommended by HENSHER et al. (2005). In order to identify the relevant organic product attributes for the choice experiment, we consulted business leaders and organisations. A literature review of organic food complemented the information from the consultation. Four attributes with three attribute levels were identified separately for the organic options. The attributes for the organic apples were the absence or reduction of pesticide residues and higher vitamin C content. The absence or reduction of antibiotic residues and the enhanced omega-3 fatty acids were included for the organic milk options, while the organic beef alternatives had a higher content of omega-3 fatty acids and the organic cattle were fed with organic feed. The price and the local region were considered for all three products. The attributes and attribute levels are presented in Table 1. The different price levels were based on real consumer prices in Germany in 2009 (AMI, 2010).

Attributes and their levels were combined according to an experimental design to create choice sets. The purpose of an experimental design is to combine the attributes and their levels in such a way that is statistically efficient by maximising and balancing the orthogonality

(LUSK and NORWOOD, 2005). 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.

Table 1: Attributes and attribute levels used in the choice experiment survey

	Organic apples	Organic milk	Organic beef
Pesticide residues	99.9% less; 95% less; 35% less	–	–
Antibiotic residues	–	99.9% less; 75% less; 50% 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; the 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

The survey included a variety of questions, including socio-economic characteristics and attitude items (for example trust and risk acceptances). 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. Table 2 presents sample statistics of the respondents. Overall the sample constitutes a good representation of the German population.

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	0.19	0.39
A-level	0.14	0.35
Professional education	0.42	0.49
University degree (incl. Ph.D.)	0.22	0.41

Source: author's own presentation

4 Empirical Results

The results of the simulated maximum likelihood estimates for the mixed logit for apples, milk, and beef are presented in Table 3.[2] The Independence of Irrelevant Alternatives 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%. Mixed logit allows for unrestricted substitution pattern implied by the Independence of Irrelevant Alternatives property (TRAIN, 2003). A likelihood ratio test is used to calculate the set of random parameters as described by HENSHER et al. (2005). It is further 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 to be bounded on both sides. 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 likelihood ratio 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 likelihood ratio tests reject the null hypothesis that the conditional logit model fits the data better than the mixed logit for all products.

Table 3 indicates a strong statistical significance of the mean coefficients for apple, milk, and beef attributes at the level of 1% (at the level of 10% for organic apples without pesticide residues and organic farm-grown feed in the case of organic beef). Model 1 indicates that consumers showed high preferences for locally produced apples, without 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*, were positive and statistically significant, implying that respondents preferred products produced in *Germany* and low pesticides. The constant parameter represents the conventional option and is negative and statistically significant. This implies that consumers prefer organic apples. For milk and beef products, it is observed that consumers prefer organic products with higher contents of omega-3 fatty acids, those produced in the region, and sold at lower prices (model 2 and 3). There is statistically significant preference for organic milk without antibiotic residues 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 the local attribute is more important than all other attributes considered by the respondents. This is probably because consumers trust more in products that are locally produced. The rationale behind localisation is the protection of the local environment and the consideration of sustainability aspects.

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 et al., 2005). The standard deviations of all random parameters were significant at the level of 1% (except vitamin C for apples and omega-3 fatty acids for milk), indicating preference heterogeneity in the population.

The standard deviations of random parameters may be correlated with other random parameters and therefore not independent. To analyse 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 et al., 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

[2] The mixed logit models were estimated using NLOGIT software version 4.0 (ECONOMETRIC SOFTWARE INC., 2007).

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).

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)	-7902.682	-8218.214	-8048.631
Simulated log likelihood at convergence	-7683.006	-8054.612	-7953.003
Likelihood ratio test *($X^2_{0.99}(17)=40.79$)*	439.352	327.204	191.256
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

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 et al., 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 were less price-sensitive, whereas individuals with a lower trust level were more price-sensitive.

Willingness-to-pay estimates obtained from Mixed Logit

Willingness-to-pay estimates are the derivation of the marginal rate of substitution between attributes and purchase price. Constraining the distribution from which the random parameters are drawn derives behaviourally meaningful willingness-to-pay values from the mixed logit (HENSHER and GREENE, 2003).[3] Hence, it is possible to use conditional constrained random parameters.[4] The willingness-to-pay estimates and the 95% confidence intervals are presented in Table 4.

The results indicate that male and female respondents have a positive willingness-to-pay (0.02 Euros - 0.23 Euros) for all organic apple attributes. Both, males and females have a negative willingness-to-pay (-1.50 Euros and -1.35 Euros) for conventional apples.

The results also indicate a positive willingness-to-pay for organic milk attributes. In particular, females are willing to pay 0.35 Euros more for a higher omega-3 fatty acids content, 0.55 Euros more for milk from their region, and 0.57 Euros more for the reduction of antibiotic residues. Male respondents have a higher willingness-to-pay 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 willingness-to-pay for the conventional option (-0.13 Euros), male respondents showed a positive willingness-to-pay for the conventional milk (1.14 Euros).

Regarding the results for beef products (Table 4), females have a positive willingness-to-pay for the organic beef attributes (0.26 Euros more for 100% organic farm-grown feed, 0.49 Euros more for omega-3 fatty acids, and 1.9 Euros more for beef from the region). Males have higher WTPs for the attributes omega-3 fatty acids (0.61 Euros) and the region (2.21 Euros). However, females value a higher willingness-to-pay for the organic product to avoid the conventional beef (2.34 Euros) than males (0.88 Euros).

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[3] In this study, the spread of the price parameter for apples and beef is constrained to the mean as recommended by HENSHER et al. (2005), whereas the spread of the price parameter for milk is constrained to be half of the mean price parameter to calculate meaningful willingness-to-pay values.

[4] This means that common choice-specific parameter estimates are conditioned on the choices that are observed to have been made by an individual (HENSHER et al., 2005).

Table 4: Willingness-to-pay estimates for female and male respondents obtained from mixed logit (apples, milk, and beef)

	Female Estimates	Willingness-to-pay [95% CI]	**Male** Estimates	Willingness-to-pay [95% CI]	ΔWTP ($CI_{\_female}$ vs. $CI_{\_male}$)[a]
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 [0.02 - 0.25]	1.1077*** (0.3507)	0.14 [0.01 - 0.28]	-0.01***
Vitamin C increase of 25%	1.0422*** (0.3473)	0.11 [-0.05 - 0.27]	0.842*** (0.2725)	0.11 [0.02 - 0.2]	0
Local region	2.1217*** (0.6737)	0.23 [0.04 - 0.42]	1.5018*** (0.4428)	0.19 [0.03 - 0.36]	0.03***
Non-random parameters in utility functions					
Pesticide residue reduction of 95%	0.6724*** (0.1992)	0.07 [0.02 - 0.12]	0.2958*** (0.104)	0.04 [0.01 - 0.06]	0.03***
From Germany	0.2464** (0.1151)	0.03 [0.01 - 0.04]	0.1413 (3.5904)	0.02 [0.01 - 0.03]	0.01***
Constant	-14.001*** (4.8169)	-1.5 [-2.52 - -0.49]	-10.649*** (3.5904)	-1.35 [-2.29 - -0.42]	-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)	0.57 [-0.83 - 1.97]	0.3199*** (0.0483)	0.98 [-2.14 - 4.09]	-0.41***
Omega-3 fatty acids increase of 30%	0.2045*** (0.0368)	0.35 [0.05 - 0.65]	0.1911*** (0.0371)	0.58 [-1.04 - 2.21]	-0.23***
Local region	0.322*** (0.0468)	0.55 [0.03 - 1.07]	0.1868*** (0.0475)	0.58 [-1.04 - 2.21]	-0.03**
Non-random parameters in utility functions					
Antibiotic residue reduction of 75%	0.3111*** (0.0557)	0.53 [0.07 - 0.99]	0.1811*** (0.0533)	0.55 [-0.98 - 2.08]	-0.02
From the state	0.0724 (0.0486)	0.12 [0.02 - 0.23]	0.1147*** (0.1909)	0.35 [-0.62 - 1.32]	-0.23***
Constant	-0.074 (0.1937)	-0.13 [-0.23 - -0.02]	0.3748** (0.1909)	1.14 [-2.03 - 4.31]	-1.27***
Beef					
Random parameters in utility functions					
Purchase price (€)	-0.6455*** (0.0632)		-0.4855*** (0.0649)		
100% organic farm-grown feed	0.0878** (0.0372)	0.26 [-0.46 - 0.98]	0.0491 (0.0391)	0.19 [-0.3 - 0.69]	0.07***
Omega-3 fatty acids increase of 30%	0.1576*** (0.0333)	0.49 [0.1 - 0.87]	0.1538*** (0.0361)	0.61 [0.03 - 1.19]	-0.12***
Local region	0.616*** (0.0461)	1.9 [0.41 - 3.4]	0.5547*** (0.0488)	2.21 [0.11 - 4.31]	-0.31***
Non-random parameters in utility functions					
From Germany	0.1721*** (0.0369)	0.53 [0.11 - 0.95]	0.2062*** (0.0394)	0.82 [0.04 - 1.6]	-0.28***
Constant	-0.757*** (0.0941)	-2.34 [-4.18 - -0.5]	-0.223** (0.097)	-0.88 [-1.73 - -0.04]	-1.46***
Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1					

[a] $CI_{\_female}$ vs. $CI_{\_male}$ denotes a *F*-test for equality of mean for the two willingness-to-pay measures.
*indicates significant willingness-to-pay differences at 95% level, **at 99% level, and ***at 99.9% level.

Source: author's own presentation

Differences in willingness-to-pay

The numerical differences presented in the far right column of Table 4 suggest that male respondents have a higher willingness-to-pay for milk and beef attributes and a lower willingness-to-pay for apple attributes than female respondents.

For the purpose of detecting significant differences an *F*-test was used to test the null hypothesis of equality of means for the willingness-to-pay measures in the two samples. The results indicate that, for all three products, there are significant differences in the willingness-to-pay values between the two samples: the null hypothesis of equal willingness-to-pay could be rejected in nearly all cases at the 1% level (except for vitamin C increase for apples and antibiotic residue reduction of 75% for milk). Hence, males and females have a different willingness-to-pay. In the case of male respondents all apple attributes are valued lower. While lower willingness-to-pay values for milk and beef attributes are observed for female respondents. Hence, the willingness-to-pay results indicate gender-specific differences for the examined products of this study. This observation is consistent with that of EISINGER-WATZEL and HOFFMANN (2010) who found that the percentage of females who reported buying organic food was higher compared to males. They concluded that organic consumers, especially females, show a more favourable food consumption and therefore a healthier lifestyle than non buyers. The findings are also in line with other studies that show differences in preferences between males and females (CROSON and GNEEZY, 2009; ECKEL and GROSSMAN, 2008).

5 Conclusions

This study used mixed logit to analyse consumers' preferences for organic food products in Germany. The empirical results indicate that significant preference heterogeneity exists for organic apple, milk, and beef product attributes among consumers. In particular, consumers showed high preferences for locally produced apples, without 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 in the region, (without antibiotic residues in the case of milk), and sold at lower prices. The willingness-to-pay results obtained from mixed logit indicate that female respondents have higher willingness-to-pay for apple attributes, while male respondents are willing to pay more for milk and beef attributes.

The findings of this study indicate that some consumer groups are willing to pay high price premiums for specific organic food attributes, and to some extent for locally produced food. Hence, policy-maker should support the sales of organic and locally produced food products.

Due to the gender differences between the products, there is a need to adopt communication strategies that integrate product-specific information to consider the gender-specific WTPs.

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