A Demand System Analysis of Organic and Conventional Fresh Milk in Germany Segmented by Consumer Groups*

Rebecca Schröck
Institute of Agricultural Policies and Market Research
Justus-Liebig-University of Giessen, Senckenbergstr. 3, 35390 Gießen
Email: rebecca.schroeck@ernaehrung.uni-giessen.de

Paper prepared for presentation at the EAAE 2011 Congress
Change and Uncertainty
Challenges for Agriculture,
Food and Natural Resources

August 30 to September 2, 2011
ETH Zurich, Zurich, Switzerland

* The article was written in the framework of a research project which is funded by the German Federal Ministry of Education and Research (BMAS). The project funding reference number is 2808OE148. The author takes full responsibility for the contents of this paper.
Special thanks go to the staff members of the Department of Agricultural and Food Marketing at the University of Kassel under the direction of Prof. Dr. Ulrich Hamm. They prepared the data for this research project and provided them to the Institute of Agricultural Policies and Market Research at the University of Giessen for further research.

A Demand System Analysis of Organic and Conventional Fresh Milk in Germany Segmented by Consumer Groups

1 Introduction

In Germany as well as in most industrialized countries the market for organic food has grown rapidly within the last few years. In 2009, organic food sales in Germany added up to 5.8 bn. €, representing 3.4 % of total food sales (BÖLW 2010). Organic milk, in particular, accounted for 14 % of retail fresh milk sales, underlining that milk plays an important role in the organic food market (BÖLW 2009). However, organic milk sales are distributed quite heterogeneously between consumer groups: The committed buyers of organic milk account for just 5 % of total milk expenditures but for more than 87 % of total organic milk expenditures.

Except for fresh produce, organic milk was one of the first organic products available to a considerable share of consumers (DEMERITT 2004). In its early stage of introduction, in Germany as well as in the U.S., brand products led the way, which were mainly sold by direct sales or in specialty stores (DIMITRI & VENEZIA 2007). Since then, the competitive structure of the organic milk market and the range of products offered have changed dramatically. Discounters and supermarkets have entered the market. This development has been attended by the appearance and expansion of organic private labels. Currently, nearly every discounter and supermarket offers both organic and conventional milk. Quite often consumers have wide choices between brand products and those of private-labels. Thus, the organic milk market in Germany now seems to be well-established.

The typical finding of studies that investigate consumer responsiveness with respect to organic milk pricing is that the demand for organic milk is much more elastic than the demand for conventional milk (see e.g., GLASER & THOMPSON 2000; DHAR & FOLTZ 2005; JONAS & ROOSEN 2008; ALVIOLA & CAPPS 2010). However, these studies were mainly conducted in earlier stages of the organic milk market. As a result of the structural changes described above, it is questionable whether prior studies can account appropriately for the current market analysis. Given this background, the objective of this study is to update and to extend the analysis of household demand for organic and conventional milk in Germany. Combining actual purchase and demographic data and applying a two-step demand system approach, the study identifies and quantifies the factors determining the demand for organic and conventional fresh milk. This paper contributes to the body of literature by providing estimates of price and expenditure elasticities not only for the whole population but also for several consumer groups whose respective population shares will probably change in future. Estimating demand elasticities at a disaggregated level with simultaneous consideration of structural and demographic trends allows for predicting future demand more accurately.

The article is organized as follows: Section 2 surveys the hitherto existing literature on the demand for organic milk. In section 3, the conceptual model is presented. Section 4 introduces the data, the *GfK Homescan Panel*. Section 5 covers the econometric evidence and provides interpretations of the results. Finally, conclusions are presented in section 6.

2 Literature review

There are two strands of organic food research that are closely linked to the present paper. The first one examines the organic consumer profile with respect to sociodemographic characteristics, as well as attitudes and cultural norms. The second one analyzes consumer purchasing behaviour – especially their responsiveness to changes in prices and income.

Scientific answers to the question 'Who is the organic food consumer?' are really multifaceted and sometimes contradictory. Studies conducted in the U.S. often suggest that organic consumers are female, married, wealthy, white and well-educated (e.g., BUZBY & SKEES

1994; THOMPSON 1998; GOVINDASAMY & ITALIA 1999; HUGHNER et al. 2007; SMITH, HUANG & LIN 2009; DETTMANN & DIMITRI 2010). However, results are not uniform, neither with respect to socioeconomic nor to demographic characteristics. In fact, findings regarding consumer profile and behaviour seem to depend strongly on period, region and methods of the study as well as on the commodity group and the sample[1]. Therefore, further research should specify these influencing factors and quantify their impact.

Relating to the second strand of organic food research, Table 1 reviews analyses that quantify organic milk consumer behaviour. It shows country, sample period and estimation methods together with a short classification of the data base. GLASER and THOMPSON (2000) analyze the demand for organic and conventional milk in the U.S. using monthly food retailing scanner data. While conventional milk is differentiated into brand and private-label milk, the study does not distinguish between any subcategories for organic milk. Applying a Linear Approximated Almost Ideal Demand System (LA/AIDS), the authors find price elasticities for conventional private-label and conventional brand milk of -0.66 and -0.73, respectively. According to their results, demand for organic milk is highly price-elastic (-3.64). Since the organic milk price is generally higher than the brand and the private-label milk prices, the authors conclude that the higher the price level of the milk product is, the more elastically consumers react (GLASER & THOMPSON 2000, 13).

Price elasticities for conventional milk estimated by JONAS and ROOSEN (2008) show a similar magnitude: -1.01 for conventional private-label and -0.96 for conventional brand milk. For organic milk the authors find an even more elastic demand than GLASER and THOMPSON (- 10.17). This result indicates that organic milk consumers are highly price sensitive and that food retailers consequently face a very constrained price setting potential.

Table 1. **Review of studies analyzing the demand for organic milk**

Authors	Country	Sample period	Data	Estimation method
GLASER & THOMPSON (2000)	U.S.	1988 - 1999	AC Nielsen and IRI retail scanner data	AIDS
DHAR & FOLTZ (2005)	U.S.	1997-2002	IRI retail scanner data for 12 U.S. cities	Q-AIDS
JONAS & ROOSEN (2008)	Germany	2000-2003	GfK Homescan Panel	LA/AIDS
MONIER et al. (2009)	France	2005	French TNS Worldpanel, Homescan data	LA/AIDS
ALVIOLA & CAPPS (2010)	U.S.	2004	Nielsen Homescan Panel data	Heckman two-step procedure
CHOI & WOHLGENANT (2010)	U.S.	2004/ 2005	Nielsen Homescan Panel data	LA/AIDS

Source: Own compilation.

DHAR and FOLTZ (2005) who apply a quadratic AIDS (Q-AIDS) find own-price elasticities for organic and conventional milk to be -1.4 and -1.0, respectively. ALVIOLA and CAPPS (2010, 385) present own-price elasticity estimates of -0.87 for conventional milk and of -2.0 for organic milk. Regarding the income elasticity they find organic milk to be a necessity and conventional milk to be an inferior good. Hence, a consolidated view of previous studies indicates that demand for organic milk is much more elastic than demand for conventional milk.

However, MONIER et al. (2009) and CHOI and WOHLGENANT (2010) arrive to conflictive conclusions. In contrast to the studies presented above, price elasticity estimated by MONIER et al.

[1] There are numerous studies investigating the organic consumer profile using various methodological approaches. See, e.g., THOMPSON & KIDWELL (1998), BRUHN (2002), HILL & LYNCHEHAUN (2002), ZMP (2003), LI, ZEPEDA & GOULD (2007), ZEPEDA & LI (2007), JONAS & ROOSEN (2008), WIER et al. (2008), ZHANG et al. (2008), MONIER et al. (2009), PLAßMANN & HAMM (2009) and RIEFER & HAMM (2009).

(2009) is higher for non-organic milk (-1.02) than for organic milk (-0.38). However, the price elasticity for organic milk is not significantly different from zero. CHOI and WOHLGENANT (2010) analyze the U.S. milk market at a disaggregated level. They define 20 milk types by three different characteristics: fat content, flavour and organic claim. The results indicate an elastic demand for both organic and conventional milk.

The number of studies on the subject shows that there actually is empirical evidence for diverse organic milk markets. However, most studies are conducted in the U.S.. Econometric analyses with particular emphasis on the German market are scarce. Considering that the size and the structure of the U.S. organic milk market differs from that in Germany, it is likely that consumer behaviour and especially their price sensitivity is not the same in both countries.

3 Methodological approach

In line with previous research, this study applies a demand system, i.e. the Almost Ideal Demand System (AIDS; see DEATON & MUELLBAUER 1980) to analyze the demand for organic and conventional milk. The demand for fresh milk is assumed to be separable from the demand for other foods, i.e. a two-stage budgeting approach is applied. First, the households decide on their optimal expenditures on fresh milk. Second, the households allocate the milk expenditure to the different milk types. It is postulated that households maximize their utility function subject to their milk budget x_{ht}. Applying an AIDS, the expenditure share of household h on milk type i in period t, w_{iht}, can be expressed as follows:

$$(1) \qquad w_{iht} = \alpha_i + \sum_{j=1}^{n} \gamma_{ij} \log p_{jht} + \beta_i log(x_{ht}/P^*_{ht}) + u_{iht} \; .$$

n is the number of different milk products in the demand system, p_j is the price of the jth milk type, u is an error term. P_{ht} denotes the price index. α, β, γ and u are the parameters to be estimated. To reduce the computational complexity we use the Linear Approximated AIDS (LA/AIDS) which replaces the original translog price index by the linear Stone Index:

$$(2) \qquad \log P^*_{ht} = \sum_{j=1}^{n} \overline{w}_{jt} \log p_{jht} \; .$$

$\overline{w}$ denotes the sample mean expenditure share. According to microeconomic theory, the LA/AIDS equation defined in *(1)* has to fulfill the constraints of adding up ($\sum_i \alpha_i = 1, \; \sum_i \beta_i = 1, \; \sum_i \gamma_{ij} = 0$), homogeneity ($\sum_j \gamma_{ij} = 0$) and symmetry ($\gamma_{ij} = \gamma_{ji}$).

In the following the LA/AIDS model specified in equation *(1)* is refined in order to (a) incorporate a set of sociodemographic variables into the demand system, (b) to account for dynamic changes in consumer behaviour and (c) to deal with the problem of censoring.

Food choices, and especially the choice between organic and conventional food are affected by sociodemographic and economic factors (GOULD, COX & PERALI 1991, 213). It is assumed that sociodemographic variables reflect taste and preferences which, in turn, determine the consumption of organic and conventional milk. The above LA/AIDS specification can be modified to incorporate the impact of sociodemographic variables Z_{kht} by using the method of demographic translation. This method preserves the linearity of the demand system and allows demographic differences to shift both the intercept and elasticity parameters (DHAR & FOLTZ 2005, 220). Under demographic translating, the constant term in the budget share equation *(1)*, α_i, is composed of a constant α_0 and the impact of sociodemographic variables. Z_{kht} denotes the k^{th} sociodemographic variable in household h and period t, $k=1,\ldots,K$. Thus, the LA/AIDS is assumed to take the following form:

$$(3) \qquad w_{iht} = \alpha_{i0} + \sum_k \alpha_{ik} Z_{kht} + \sum_j \gamma_{ij} \log p_{jht} + \beta_i \log(x_{ht} / P^*_{ht}) + u_{iht} \; .$$

The adding up restriction requires that $\sum_{i=1}^{n} \alpha_{i0} = 1$ and $\sum_{i=1}^{n} \alpha_{ik} = 0$.

Analyzing a sample period of five years, the problem of temporally changes in consumer behaviour arises. Recent shifts in the structure and the product assortment of the organic milk market have certainly influenced consumer behaviour. Presumably, general tendencies that do not show any linkage to prices and income such as technological progress (e.g. implementation of Extended-Shelf-Life milk), increasing importance of eating away from home and an increasing awareness of healthy eating contributed to the growth in the organic milk demand.

There are different approaches when incorporating dynamic adjustment processes in demand systems. Thoroughly, more than one approach can be applied at the same time (MOSCHINI & MORO 1996, 248). First, it is corrected for autocorrelation and accounted for habit formation by incorporating the differentiated endogenous variable Δw_{iht} (HANSEN 1993, 310). Considering the fact that Δw_{iht} is correlated with the error term *u,* WICKENS and BREUSCH (1988, 189f) suggest to include the lagged consumption $\Delta w_{ih,t-1}$ as an instrumental variable instead of using Δw_{iht}. Second, a *trend* is considered in order to account for continuously changing consumer behaviour and structural changes over time. Thus, equation *(3)* is again modified:

$$(4) \qquad w_{iht} = \alpha_{i0} + \sum_{k} \alpha_{ik} Z_{kht} + \sum_{j} \gamma_{ij} \log p_{jht} + \beta_i \log(x_{ht} / P^{*}_{ht}) + \sum_{j}^{n-1} \sigma_{ij} w_{jh,t-1} + \delta_i trend + u_{iht}.$$

In order to deal with the problem of zero observations, it is assumed that household's purchase decisions can be modeled as a two-step process. The application of the two-step procedure developed by SHONKWILER and YEN (1999) allows for estimating the demand system using all observations. Thus, households first decide whether to buy a certain milk type or not (participation decision). If they decide to buy, they subsequently determine the quantity demanded (consumption decision). Each of the household's decisions is determined by a different set of explanatory variables. In the first step, a multivariate probit regression examines which determinants influence the purchase probability. The probability is then used as an instrument to incorporate the censoring latent variables in the second-step estimation of the LA/AIDS (JONAS & ROOSEN 2008, 195). For each milk type *i*, the first-step decision is modelled as a dichotomous choice problem. The dependent variable is $Y_{iht}=1$ if household *h* purchased milk type *i* at least once in period *t*, otherwise $Y_{iht}=0$.

$$(5) \qquad Y_{iht} \left\{ user\ household = 1 \right\} = X_{iht} \beta_i + u_{iht} \quad where \quad u_{iht} \left| X_{iht} \sim N(0,1). \right.$$

X_{iht} is the vector of independent variables, β_i represents the corresponding coefficients associated with X_{iht}. In order to consider household-specific heterogeneity and habit formation, the independent vector contains not only sociodemographic variables but also past consumption decisions, i.e., the quantity demanded of the respective milk type in the previous year.

In demand theory, prices are crucial in determining consumers' food purchases. As organic milk is listed in more and more retail formats, it becomes available to a wider consumer base, which is presumably less affluent and more price sensitive. Therefore, (organic) *price premia* can be assumed to play an increasingly important role not only in the second-step but also in the first-step decision (SMITH, HUANG & LIN 2009: 735). The price premia are computed as the percentage above the average price of conventional private-label (CPL) milk, i.e. the milk type with the lowest price, and also incorporated as explanatory variables in the first step:

$$(6) \qquad price\ premium_{iht} = \frac{p_{iht} - \overline{p}_{CPL,t}}{\overline{p}_{CPL,t}}.$$

The consumption participation decision is hence modeled as a function of sociodemographic variables, past consumption and price premia. In a next step, the normal probability density function *pdf* (ϕ_{iht}), and the normal cumulative distribution function *cdf* (Φ_{iht}) were estimated

on the basis of the probit regression results. These probability functions enter the second-step demand system (specified in equation *(4)*) as latent variables correcting for censoring. Hence, the final specification of the expenditure share equation is

$$(7) \qquad w_{iht} = \left[\alpha_{i0} + \sum_k \alpha_{ik} Z_{kht} + \sum_j \gamma_{ij} \log p_{jht} + \beta_i \log(x_{ht} / P^*_{ht}) + \sum_j^{n-1} \sigma_{ij} w_{jh,t-1} + \delta_i trend \right] \times \Phi_{iht} + \lambda_i \phi_{iht} + u_{iht} .$$

Equation *(7)* is estimated as a demand system with (n-1) equations[2] via seemingly unrelated regressions. Price and expenditure elasticities are computed using the formulas given by GREEN and ALSTON (1990):

(8) expenditure elasticity: $$\hat{\eta}_i = 1 + \frac{\hat{\beta}_i}{\overline{w}_i} \cdot \hat{\Phi}_i$$

(9) uncompensated own- and cross price elasticity: $$\hat{\varepsilon}_{ij} = \hat{\Phi}_i \cdot \left(\frac{\hat{\gamma}_{ij} - \hat{\beta}_i \overline{w}_j}{\overline{w}_i} \right) - \delta$$

δ denotes the Kronecker Delta and is $\delta=1$ for $j=i$ and $\delta=0$ for $j\neq i$. Finally, the demand system was estimated separately for different consumer groups.

4 Data and sample description

The analysis is based on the *GfK Consumer Scan* scanner panel dataset on food purchases of German households. Since the beginning of 2004 the *GfK* has put special efforts to heighten the representativeness of the panel with respect to organic food markets. Thus, the *GfK* data now has overcome its primary troubles with the distinction of organic and non-organic products. The *GfK* panel offers a perfectly qualified dataset for this kind of analysis in two aspects: First, food purchase information is directly linked to sociodemographic information about the household. Second, reporting grocery purchases of 20,000 households[3] from a wide variety of retail outlets including organic food shops and covering a sample period of five years (January 2004 to December 2008) the panel provides a really unique sample size.

Compiling detailed information for each milk purchase like date of purchase, amount bought, price[4], brand chosen, name of the supermarket chain, fat content and organic claim, the dataset permits analyses at a quite disaggregated level. Additionally, the dataset includes sociodemographic variables such as information about age, education, profession and gender of the household head as well as characteristics of the key household shopper. Moreover, the household's net income, household size and number of kids are reported.

In the following, milk will be distinguished into private-label and brand milk both for conventional and organic milk. Consequently, four different milk types are analyzed: organic brand (OB) milk, organic private-label (OPL) milk, conventional brand (CB) milk and conventional private-label (CPL) milk.

---

[2] In doing so, the author follows SHONKWILER and YEN (1999). It was checked that the estimated coefficients were stable regardless which equation was dropped.

[3] The households in the *GfK Homescan Panel* comprise a stratified random sample, selected on demographic as well as geographic targets. Stratification ensures that the sample represents the sociodemographic profile of consumers in Germany according to the German microcensus.

[4] Panelists of the *GfK Consumer Scan* do not report exact prices but total quantity and expenditures for each food item they bought. Prices are computed as the unit value price for each purchase by dividing the reported expenditures by the corresponding quantity. These unit values may also reflect quality differences and, consequently, the estimated elasticities may be biased. However, the author considers the commodities involved in this analysis to be sufficiently disaggregated and homogeneous to minimize the degree of bias (see COX & WOHLGENANT 1986). A second problem related to unit values is that they do not take effects of price promotions into account. However, for milk this should not cause serious bias, because milk is rarely set on special offer in Germany (LZ 2005). A third problem is that prices can only be constructed from reported purchases. Prices faced by non-users remain unobserved. Therefore, missing prices are replaced through regional averages calculated on data for consuming households (cf. JONAS & ROOSEN 2008, 197).

Table 2. **Sample means of milk expenditures and household characteristics by consumer groups in Germany, 2004-2008**

Variable	Whole sample		Non-Buyers		Occasional Buyers		Committed Buyers	
	M	SD	M	SD	M	SD	M	SD
Milk quantities purchased (sample means in liters/year)								
OB milk	1.26	(0.045)	0.01	(0.000)	2.04	(0.075)	26.98	(0.952)
OPL milk	1.42	(0.044)	0.01	(0.001)	3.13	(0.086)	28.93	(0.900)
CB milk	42.62	(0.262)	42.93	(0.281)	50.77	(0.999)	22.41	(0.685)
CPL milk	78.30	(0.371)	81.44	(0.402)	70.95	(1.190)	23.17	(0.831)
Budget shares (sample means in % of total milk expenditure)								
OB milk of total milk expenditures	0.01	(0.000)	0.00	(0.000)	0.02	(0.001)	0.28	(0.006)
OPL milk of total milk expenditures	0.02	(0.000)	0.00	(0.000)	0.04	(0.001)	0.31	(0.006)
CB milk of total milk expenditures	0.35	(0.001)	0.35	(0.001)	0.42	(0.004)	0.22	(0.004)
CPL milk of total milk expenditures	0.62	(0.001)	0.65	(0.001)	0.51	(0.004)	0.18	(0.004)
Income [a)] (sample means in Euro/month)								
Weighted per-capita net income	1,323	(2.101)	1,306	(2.196)	1,428	(8.285)	1,531	(11.51)
Price premia (sample means, percentage above the average price of CPL milk)								
OB	1.57	(0.064)	1.57	(0.062)	1.53	(0.390)	1.59	(0.476)
OPL	1.51	(0.058)	1.51	(0.057)	1.48	(0.332)	1.53	(0.357)
CB	1.14	(0.093)	1.13	(0.095)	1.22	(0.384)	1.28	(0.550)
Nationality & Gender (% of the sample)								
German nationality	0.94	(0.001)	0.92	(0.001)	0.93	(0.004)	0.93	(0.005)
Female person	0.64	(0.002)	0.64	(0.002)	0.64	(0.007)	0.66	(0.009)
Region (% of sample)								
West	0.26	(0.002)	0.27	(0.002)	0.23	(0.006)	0.23	(0.008)
East	0.22	(0.002)	0.23	(0.002)	0.16	(0.005)	0.11	(0.006)
North	0.18	(0.002)	0.18	(0.002)	0.17	(0.006)	0.18	(0.007)
South	0.34	(0.002)	0.33	(0.002)	0.45	(0.007)	0.48	(0.010)
Urbanization (% of sample)								
Small cities & rural areas	0.75	(0.002)	0.74	(0.002)	0.77	(0.006)	0.81	(0.008)
Large city (≥ 100,000 inhabitants)	0.35	(0.002)	0.32	(0.002)	0.35	(0.007)	0.40	(0.009)
Household size & Kids (sample means or % of sample)								
Household size (sample mean)	2.46	(0.005)	2.47	(0.005)	2.42	(0.017)	2.31	(0.022)
total number of kids (sample mean)	0.51	(0.003)	0.52	(0.004)	0.47	(0.012)	0.46	(0.015)
Kids between 0 and 7 years (%)	0.14	(0.001)	0.14	(0.001)	0.15	(0.005)	0.17	(0.007)
Education [b)] (% of sample)								
Education level 1	0.29	(0.002)	0.30	(0.002)	0.23	(0.006)	0.16	(0.007)
Education level 2	0.28	(0.002)	0.28	(0.002)	0.23	(0.006)	0.22	(0.008)
High school diploma	0.18	(0.002)	0.18	(0.002)	0.18	(0.006)	0.19	(0.008)
University degree	0.25	(0.002)	0.24	(0.002)	0.35	(0.007)	0.43	(0.010)
Age (% of sample)								
< 30 years	0.08	(0.001)	0.08	(0.001)	0.07	(0.004)	0.07	(0.005)
30-49 years	0.43	(0.002)	0.43	(0.002)	0.40	(0.007)	0.45	(0.010)
50-69 years	0.37	(0.002)	0.37	(0.002)	0.40	(0.007)	0.38	(0.009)
≥ 70 years	0.12	(0.001)	0.12	(0.001)	0.13	(0.005)	0.10	(0.006)
Profession (% of sample)								
Employees & Public servants	0.43	(0.002)	0.42	(0.002)	0.45	(0.007)	0.54	(0.010)
Workers & Apprentices	0.15	(0.001)	0.16	(0.002)	0.10	(0.005)	0.06	(0.005)
Freelancers & Self-employed	0.05	(0.001)	0.05	(0.001)	0.06	(0.003)	0.06	(0.005)
Housewives, Pensioners & Students	0.33	(0.002)	0.33	(0.002)	0.36	(0.007)	0.32	(0.009)
Jobless persons	0.04	(0.001)	0.04	(0.001)	0.03	(0.003)	0.02	(0.003)
No. of observations	64,385		57,292		4,427		2,666	
% of observations	100.00		88.98		6.88		4.14	
No. of households	**22,885**		**14,982**		**6,839**		**1,064**	

[a)] The net income is computed as the equivalent household disposable income. Household members are weighted pursuant to the OECD equivalence scale.

[b)] Education levels are defined according to the German schooling system: level 1 – Hauptschulabschluss, level 2 – Realschulabschluss, level 3 – Abitur (university-entrance diploma), level 4 – university degree.

Source: Own computation on the basis of GfK Consumer Scan panel data, 2004-2008.

Demand is analyzed on an annual data basis. The sample consists of 22,885 milk consuming households[5] and 64,385 observations. Table 2 provides information on the sample demographic distribution. The average weighted per-capita income[6] is about 1,320 Euro and the average household size is 2.5. The majority of households is of German nationality (94 %) and lives in the South (34 %). In 64 % of the reporting households a female person is mainly responsible for food purchases. 48 % of the household heads are employed or self-employed; 43 % of them are in the age range of 30 and 49. On average, panelists spent approximately 3 % of their milk budget on organic milk.

Furthermore, table 2 gives first hints at the sociodemographic profile of non-buyers of organic milk, occasional buyers and committed buyers. Following the classification of BUDER et al. (2010), households are classified into three groups according to their organic milk budget share (OB plus OPL milk): Non-buyers spend less than 1 %, occasional buyers between 1 and 20% and committed buyers more than 20% of their milk budget on organic milk.

In total, 14,982 households are classified as non-buyers, 6,839 as occasional buyers and 1,064 as committed buyers. Comparing demographic information across these consumer groups, table 2 shows that committed buyers have on average a larger net income (1,531 Euro) than average milk buyers (1,323 Euro).

Moreover, there are regional differences: Organic milk buyers tend to live in the south and in cities. Besides the income effect, this finding could be explained by the fact that households located closer to central business districts have better access to organic food or may be more aware of healthy eating or sustainable consumption (SMITH, HUANG & LIN 2009, 740). Committed buyers show a below average household size and number of children but they are more likely to have young children up to seven years of age. Committed buyers are most likely to be employees or civil servants and most of them are middle-aged. The share of households with a university degree is well above average among committed and occasional buyers.

5 Results and Discussion

5.1 Probit regressions

Table 3 displays the results of the first-step probit regression in detail. The estimated coefficients of probit models are difficult to interpret. In nonlinear models, marginal effects are often more informative than regression coefficients themselves (CAMERON & TRIVEDI 2009, 462). To allow for a more meaningful interpretation, elasticities with respect to consumption participation are computed as $(\partial P(y>0)/\partial x)\times(\bar{x}/\bar{P})$ for the continuous variables *price premium* and *habit formation*. For discrete variables marginal effects with respect to the consumption participation decision, i.e., $\partial P(y>0)$, are reported.

Equation *(5)* is estimated for H=19,066 households and T=4 years[7]. The results confirm the impacts of sociodemographic characteristics on consumers' purchase decisions which were postulated by descriptive statistics. The higher the *income* and the higher the *educational attainment*, the more likely is the household to buy OB, OPL and CB milk. Having a per-capita income of at least 2,250 Euro increases the probability of purchasing OB (OPL, CB) milk by 0.06 (0.04, 0.11 respectively) relative to a household with an income of less than 750 Euro, ceteris paribus. As expected, the impact of income is higher on OB milk than on OPL milk.

[5] The panel is not balanced. During the sample period some households entered and others left the panel. Therefore, the number of households in this analysis exceeds the average panel size of 20,000 households.

[6] We applied the OECD-modified equivalence scale first proposed by HAAGENARS et al. (1994) to compute a weighted per-capita income. In the following we refer to this variable when talking about income.

[7] Because of the dependence on lagged consumption the sample period shortens and the number of households in the sample decreases. Consequently, the probit model is estimated for the period from 2005 to 2008.

Table 3. **First-step probit regressions: Which factors determinate the probability to buy organic and conventional milk?** Probability marginal effects[a)] and probability elasticities[b)] of demographic variables, past consumption and price premia

		%	User household of			
		Obs.	**OB milk**	**OPL milk**	**CB milk**	**CPL milk**
price premium	% price premium	---	-0.0454**	-0.2996***	-0.3839**	---
income	< 750 €	10.2	d	d	d	d
	750 € - 1249 €	35.7	0.0205***	0.0058	0.0277**	-0.0039
	1250 € - 1749 €	31.8	0.0288***	0.0206***	0.0528***	-0.0059**
	1750 € - 2249 €	14.3	0.0411***	0.0349***	0.0807***	-0.0045
	> 2249 €	8.0	0.0593***	0.0399***	0.1086***	-0.0070*
education [c)]	education level 1	26.0	d	d	d	d
	education level 2	31.2	-0.0012	0.0081	0.0079	-0.0008
	education level 3	21.3	0.0163***	0.0251***	0.0061	-0.0021
	education level 4	21.5	0.0266***	0.0486***	0.0217**	-0.0027
age	< 30 years	8.3	d	d	d	d
	30-49 years	42.8	0.0038	0.0135*	-0.0183	-0.0137***
	50-69 years	37.1	0.0047	0.0195**	0.0041	-0.0197***
	> 70 years	11.8	-0.0102*	0.0123	-0.0187	-0.0391***
profession	workers & apprentices	42.0	d	d	d	d
	employees & public servants	15.4	0.0208***	0.0233***	0.0092	0.0030*
	freelancers & self-employed	4.8	0.0245**	0.0175*	0.0385**	0.0001
	housewives, pensioners & students	33.8	0.0235***	0.0324***	0.0282**	0.0014
	jobless persons	4.0	0.0247**	0.0160	0.0200	0.0054**
nationality *(D_{nation})*	German	93.0	d	d	d	d
	others	7.0	0.0104*	0.0150*	0.0159	0.0030
urbanisation *(D_{city})*	others	67.4	d	d	d	d
	large cities	32.6	0.0076**	0.0166***	0.0066	0.0026**
single households *(D_{single})*	multi-person household	79.0	d	d	d	d
	single household	21.0	0.0042	-0.0005	-0.0175**	-0.0057***
Number of children (<18 years) *(kids18)*	no child	68.6	d	d	d	d
	1 child	14.9	0.0008	0.0130*	0.0024	0.0055***
	2 children	12.6	-0.0052	0.0016	-0.0246*	0.0030
	3 and more children	3.9	-0.0182***	-0.0001	-0.0514**	0.0076***
young children *(D_{kids07})*	no child under 7 years	85.7	d	d	d	d
	children under 7 years	14.3	0.0276***	0.0305***	0.0308***	0.0002
Gender *(D_{gender})*	male	35.1	d	d	d	d
	female	64.9	0.0099***	0.0092**	-0.0105*	-0.0039***
place of residence *(region)*	west	26.2	d	d	d	d
	east	21.8	-0.0054	-0.0186***	0.1115***	-0.0068***
	south	34.2	0.0327***	0.0268***	0.0354***	-0.0094***
	north	17.8	0.0146***	0.0071	-0.0247**	0.0009
Quantity demanded in the previous year *(habit formation)*		---	0.0978***	0.1459***	0.1532***	0.0086***
n (No. of observations)			42,707	42,707	42,707	42,707
N (No. of households)			22,885	22,885	22,885	22,885
McFadden's Adj. R^2			0.183	0.156	0.119	0.109
Adj. Count-R^2			0.158	0.145	0.085	0.000

Note. ***, **, * and (*) denote significance at 0.1, 1, 5 and 10 %, respectively; *d* denotes the dummy category not included in the estimation to avoid dummy variable trap.

[a)] Probability marginal effect is reported for discrete variables and denotes absolute change in organic milk consumption participation probability in response to one level increase for the multilevel discrete variables (income, education, age and kids18) or 0/1 change for the dummy variables.

[b)] Probability elasticity is used for continuous variables and interpreted as the percentage change in organic milk consumption participation probability in response to the percentage change in continuous variable.

[c)] Education levels are defined according to the German schooling system: level 1 – Hauptschulabschluss, level 2 – Realschulabschluss, level 3 – Abitur (university-entrance diploma), level 4 – university degree.

Source: Own computation on the basis of GfK Consumer Scan panel data, 2004-2008.

Furthermore, households where a female person is key household shopper, households living in large cities and households with young children show a higher probability to buy organic milk. However, the probability declines when there is more than one child in the household.

The impact of *age* on organic milk consumption participation seems to be non-linear. Middle-aged household heads are more likely to buy organic milk than younger (<30 years) and older households (≥70 years). Estimation results also reveal *regional differences.* For households located in the southern parts of Germany the probability of purchasing OB, OPL and CB milk increases by about 0.03, respectively, relative to households located in the west.

As expected, *prices* and *habit formation* are important determinants of the first-step decision. On average, the percentage price premium was 64 % for OB, 55 % for OPL and 32.5 % for CB milk. Probability elasticities in table 3 indicate that as the price premium of OPL milk, for example, increases by one percentage point, the probability of purchasing OPL milk lowers by 0.3 %. Interestingly, price premia show a higher impact on the participation decision with respect to OPL and CB milk than to OB milk.

The goodness of fit of the probit regressions is satisfactory. The adjusted Count-R^2, which is the proportion of correct guesses beyond the number that would be correctly guessed by choosing the largest marginal (LONG and FREESE 2006, 110ff), is 15.8 %, 14.5 % and 8.5 % for the models explaining OB, OPL and CB milk consumption participation, respectively.

5.2 LA/AIDS estimation

Section 5.2.1 presents the second-step estimation results for the whole sample. Section 5.2.2 gives a more detailed view on different consumer groups.

5.2.1 Pooled regressions for all consumers

Presenting the second-step estimation results, this paper focuses on own-price elasticities. Therefore, these elasticities will be discussed in most detail[8]. Table 4 compares elasticity estimates of this study to those of previous studies presented in section 2. The fact that previous studies rarely achieved significant price elasticity estimates for organic milk is possibly caused by considerably smaller sample sizes.

Table 4. **Comparison of uncompensated price and income/ expenditure elasticities in different analyses of organic and conventional milk markets** [a)]

	GLASER & THOMPSON (2000)	DHAR & FOLTZ (2005)	JONAS & ROOSEN (2008)	MONIER et al. (2009)	ALVIOLA & CAPPS (2010)	CHOI & WOHGENANT (2010)	Own results (2011)
sample period	1989 - 1999	2004	2000-2003	2005	2004	2004/ 2005	2005 - 2008
country	U.S.	U.S.	Germany	France	U.S.	U.S.	Germany
own-price elasticity							
CB milk	-0.73**	-1.04***	-0.96*	-1.02*	-0.87***	-1.36(*)	-0.93***
CPL milk	-0.66**		-1.01*				-0.42***
OB milk	-3.64	-1.37***	-10.17*	-0.38	-2.00***	-1.91	-0.25**
OPL milk							-0.40**
income/ expenditure elasticity							
CB milk	1.16**e)	0.97***	0.99*e)	---	-0.01i)	0.75(*) e)	0.90***e)
CPL milk	1.00**e)		1.04*e)	---			0.93**e)
OB milk	-5.73*e)	0.50***	0.73*e)	---	0.27* i)	0.60e)	1.00e)
OPL milk				---			1.10e)

Note. ***, **, * and (*) denote significance at 0.1, 1, 5 and 10 %, respectively.
a) If there are several elasticity estimates for different fat contents, here that one for whole milk is shown;
e) expenditure elasticity; i) income elasticity; --- expenditure or income elasticities were not computed.
Source: Own compilation.

[8] Tables showing the full estimation results for the pooled estimation and the estimation segmented by consumer groups presented in the following section are available from the author on request.

Comparing the magnitude of elasticity estimates of previous studies there are three basic findings. First, demand for conventional milk is inelastic or slightly elastic. Second, demand for organic milk seems to be highly elastic. Third, there is no significant difference in price elasticity between private-label and brand milk.

The present analysis confirms that demand for conventional milk is inelastic, but contradicts the other findings. Price sensitivity differs substantially between brand and private-label milk, both for conventional and for organic milk. Furthermore, the estimation results of the present study indicate an inelastic demand for organic milk, both for OB milk (-0.25) and for OPL milk (-0.40). The dissimilarity in the magnitude of own-price elasticity estimates of this study in comparison to previous studies demands a closer look.

Elasticity estimates have to be interpreted with regard to their data base, estimation procedure and sample period. These factors can provide first hints at possible causes for differences in the magnitude of price elasticity estimates. First, most of the studies only consider general retailing or do not explicitly state whether purchases in organic food shops are included in the sample or not. However, organic food purchases are at least underrepresented when focussing on the general retailing and consumer price sensitivity is naturally lower in organic food shops than in other retail formats[9].

Second, the sample period differs. GLASER and THOMPSON (2000, 15), who estimated demand elasticities separately for several periods, found that price elasticity for organic milk declined over time, whereas price elasticities for CB and CPL milk remained constant.

Thus, taking into account that the database of this study is more recent and also includes purchases in organic food shops[10], it seems plausible that price elasticities for organic milk (in absolute values) are smaller. However, results show that neither the high degree of disaggregation - as argued by JONAS and ROOSEN (2008, 203) - nor the application of AIDS - as stressed by GLASER and THOMPSON (2000, 17) - necessarily results in very elastic elasticity estimates for organic food products.

Furthermore, the fact that demand for organic milk is less elastic than demand for its conventional counterpart is feasible. Showing an absolute value of price elasticity smaller than unity, demand for organic milk resembles the demand for typical staple foods. Prices play an important role – as indicated by the significance level – and they show the expected sign. However, prices do not impact the quantity demanded as strong as they do for luxury goods. Hence, the result confirms the assumption that organic products are usually considered as necessities and are often bought 'by conviction'.

Additionally, there are fewer substitutes for organic milk than for conventional milk. Supermarkets and especially discounters typically offer only one type of organic milk – mostly fresh whole fat milk. If consumers aim to buy organic milk, a price-induced shift to long-life milk or to milk with another fat content is not always possible within one place of purchase. This fact also leads to lower absolute own-price elasticity estimates.

The estimated expenditure elasticities of this study range about unity for all milk types. Thus, a one-percentage increase in total milk expenditures does not result in a considerable reallocation of milk budget shares between the milk types.

[9] Assuming that consumers who buy organic milk 'by conviction' often attend specialised stores like organic food shops, price elasticity of organic milk consumers in organic food shops is expected to be less elastic than price elasticity of organic milk consumers in other retail formats.

[10] As a consequence of the amelioration of the data with respect to organic food, the data base of the present study is assumed to cover at least 66 % of the organic milk market while the *GfK Homescan Panel* data used by JONAS and ROOSEN (2008) represented only 36 % of the organic milk sales (BIEN & MICHELS 2007, 12f).

5.2.2 Differentiation between consumer groups

An inelastic demand implies that price campaigns at retail level are not the appropriate instrument to increase (organic) milk sales. This conclusion is based on the estimation for the whole sample presented above. As estimated price elasticities can lay the foundation for decisions concerning pricing and distribution strategies, it has to be proved whether price sensitivity is the same for all consumer groups. If not, it is important to differentiate between consumers and to pay special attention to the groups of prime importance for the organic milk market and to those with a rising share in the population. But so far, there is a lack of elasticity estimates for separate household groups with respect to organic milk in Germany. Table 5 pictures the change in consumer preferences which becomes noticeable in the increasing share of occasional and committed organic milk buyers. In 2008, committed buyers made up 5.4 % of all households but accounted for more than 90 % of total organic milk expenditures. In contrast, 87 % of the population were still non-buyers. Hence, for the future development of the organic milk market, it seems to be especially important to acquire this consumer group.

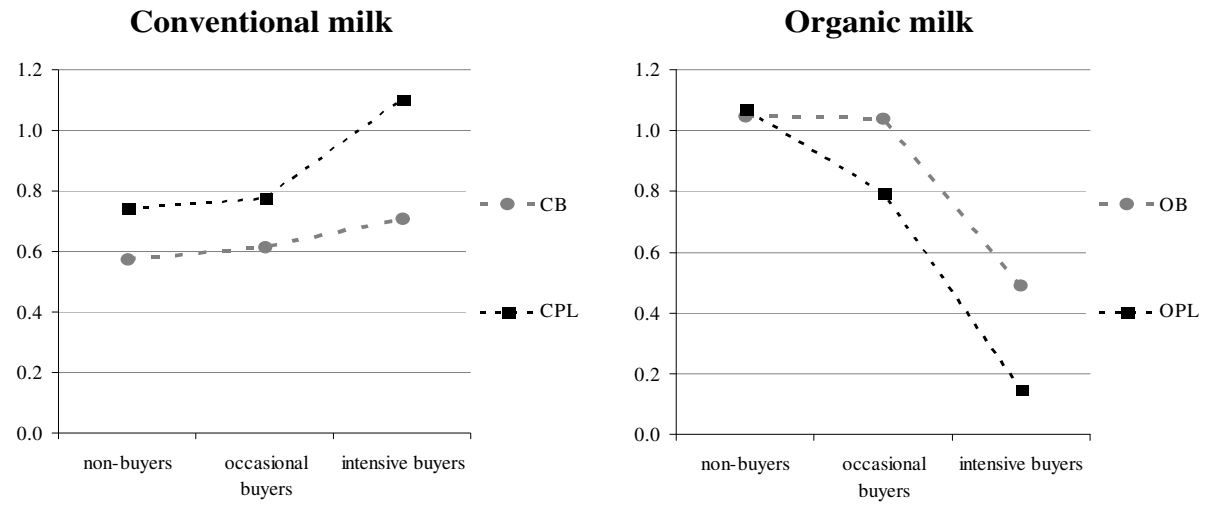
Table 5. **Percentage shares of consumer groups with respect to organic milk expenditure shares in Germany, 2004-2008**

Consumer group	2004	2005	2006	2007	2008
Non-buyers	92.2%	91.7%	89.0%	86.5%	87.1%
Occasional buyers	5.4%	5.5%	6.9%	8.3%	7.5%
Committed buyers	2.4%	2.7%	4.1%	5.2%	5.4%

Note: Households are classified according to their organic milk budget share: Non-buyers spend less than 1 %, occasional buyers between 1 and 20% and committed buyers more than 20% of their milk budget on organic milk.
Source: Own computation on the basis of GfK Consumer Scan panel data, 2004-2008.

In figure 1 the absolute value of the own-price elasticity estimate is plotted for different consumer groups. Expectedly, households that are used to buying organic milk, i.e. committed buyers, are less price-sensitive with respect to the organic milk price than non-buyers and occasional buyers (cf. figure 1, right side). On the other hand, they are considerably more price-sensitive with respect to the conventional milk price (cf. figure 1, left side). The reverse is true for non-buyers. While the demand for conventional milk is inelastic among this group, their demand for organic milk is slightly elastic.

Figure 1. **Comparison of own-price elasticities for organic and conventional milk between different consumer groups in Germany, 2005-2008**



Note: Non-buyers are defined as households that spend less than 1 %, occasional buyers between 1 and 20 % and committed buyers more than 20 % of their milk budget on organic milk.
Source: Own computation on the basis of GfK Consumer Scan panel data, 2004-2008.

These findings imply two important facts: First, when making marketing decisions it is very important to clearly define the target group. Hence, price promotions with respect to organic milk will not increase sales among current consumers, i.e. occasional and committed buyers. But a slightly elastic demand of current non-buyers implies that price reductions might attract new consumers to organic milk and might increase their expenditures on organic milk. Bearing in mind that non-buyers account for 87 % of all households in 2008 (see table 5), price promotions at retail level seems to be promising, especially in shops that are mostly frequented by non-buyers, i.e. in general retailing.

Second, the different magnitude of own-price elasticity in several consumer groups underlines that the use of average price elasticities for the population as a whole is problematic for the projection of future organic milk demand if there are significant changes in population structure or consumer preferences.

6 Conclusions and outlook

A growing number of studies deal with consumer decisions concerning organic food. However, only few provide quantitative estimates of demand elasticities. This paper contributes to the body of literature by providing own-price elasticity estimates as well as analysis of the sociodemographic determinants of demand for organic milk in Germany. In (a) using up-to-date data, (b) distinguishing between different consumer groups, (c) incorporating sociodemographic variables of the households and (d) relying upon a considerably large sample size this study is both an update and a refinement of previous research.

Applying a two-step analysis, both the likelihood of consumption participation and the consumption levels are analyzed using the *GfK Homescan Panel* data. Consumer price sensitivity is estimated separately for different milk types and for different consumer groups in Germany. The discrimination between brand and private-label products, both for conventional and for organic milk, provides a more detailed view on the characteristics and behaviour of organic consumers and non-consumers. Moreover, the traditional LA/AIDS was refined threefold by incorporating sociodemographic determinants, by considering dynamic aspects of milk demand and by accounting for censoring.

The findings of the first-step probit analysis suggest that the primary organic milk consumer is well educated, wealthy and without children living in the household. This consumer tends to live in the southern parts of Germany and in urban areas. Additionally, prices and habit formation are main determinants of the decision to buy or not to buy organic milk.

Low price elasticities in the second step indicate that once the decision to buy organic milk is made, price does not play an important role. This result is contradictory to prior studies. While demand for organic milk in previous research was found to be highly elastic, the present analysis suggests that the demand for organic milk in Germany is absolutely price-inelastic. This finding implies that the structural change in the organic milk market and in consumer preferences over the last few years result in lower consumer price sensitivity. Consequently, previous research can not be used without reservation for current market analysis.

Furthermore, an inelastic demand suggests that price campaigns at retail level are not the right instrument to increase sales and to facilitate growth. However, price sensitivity is not the same for all consumer groups. Current non-buyers show a considerably higher price responsiveness with respect to the organic milk price than households that already purchase organic milk. The combination of the first-step and the second-step results clearly reveal that there is a considerable potential to expand the organic milk market by attracting new consumers. But there is little potential to enhance the quantity demanded by extant consumers by reducing prices.

References

ALVIOLA, P.A. and O. CAPPS, JR. (2010): Household Demand Analysis of Organic and Conventional Fluid Milk in the United States Based on the 2004 Nielsen Homescan Panel. In: Agribusiness 26 (3), 369-388.

BIEN, B. and P. MICHELS (2007): Aufbau einer kontinuierlichen Berichterstattung zum Einkaufsverhalten bei ökologisch erzeugten Produkten in Deutschland unter Einbeziehung der Ergebnisse aus dem BÖL-Projekt 02OE367. Final report of research project 02OE367/F of the German 'Bundesprogramm Ökologischer Landbau'.

BÖLW Bund Ökologische Lebensmittelwirtschaft e.V.
- (2009): Zahlen, Daten, Fakten: Die Bio-Branche 2009. Berlin.
- (2010): Zahlen, Daten, Fakten: Die Bio-Branche 2010. Berlin.

BRUHN, M. (2002): Die Nachfrage nach Bioprodukten. Eine Langzeitstudie unter besonderer Berücksichtigung von Verbrauchereinstellungen. Peter Lang, Frankfurt a.M.

BUDER, F.; HAMM, U.; BICKEL, M.; BIEN, B. and P. MICHELS (2010): Dynamik des Kaufverhaltens im Bio-Sortiment. Final report of research project 2809OE014 of the German 'Bundesprogramm Ökologischer Landbau'.

BUZBY, J.C. and J.R. SKEES (1994): Consumer Want Reduced Exposure to Pesticides on Food - Charting the Costs of Food Safety. In: Food Review 17 (2), 19–22.

CAMERON, A.D. and P.K. TRIVEDI (2009): Microeconometrics Using Stata. Stata Press, Texas.

CHOI, H.-J and M. WOHLGENANT (2010): The Welfare Effect of Organic Milk. Selected Paper prepared for presentation at the Agricultural & Applied Economics Association 2010, July 25-27, Colorado.

COX, T.L. and M. WOHLGENANT (1986): Price and quality effects in cross-sectional demand analysis. In: American Journal of Agricultural Economics 68 (4), 908-919.

DEATON, A. and J. MUELLBAUER (1980): An Almost Ideal Demand System. In: The American Economic Review 70 (3), 312–326.

DEMERITT, L. (2004): Organic Pathways. In: [N]Sight magazine. Hartman Group, Inc. Bellevue, WA.

DETTMANN, R. and C. DIMITRI (2010): Who's Buying Organic Vegetables? Demographic Characteristics of U.S. Consumers. In: Journal of Food Products Marketing 16 (1), 79–91.

DHAR, T. and J.D. FOLTZ (2005): Milk by any other name… Consumer benefits from labelled milk. In: American Journal of Agricultural Economics 87 (1), 214-218.

DIMITRI, C. and K.M. VENEZIA (2007): Retail and Consumer Aspects of the Organic Milk Market. U.S. Department of Agriculture, ERS LDP-M-155-01, Washington, DC.

GLASER, K. and G.D. THOMPSON (2000): Demand for Organic and Conventional Beverage Milk. Paper presented at the WAEA Annual Meeting 2000, June 29 – July 1, Vancouver, British Columbia.

GOULD, B.W.; COX, T.L. and F. PERALI (1991):Demand for Food Fats and Oils: The Role of Demographic Variables and Government Donations. In: American Journal of Agricultural Economics 73 (1), 212-221.

GOVINDASAMY, R. and J. ITALIA (1999): Predicting Willingness-to-Pay a Premium for Organically Grown Fresh Produce. In: Journal of Food Distribution Research 30, 44–53.

GREEN, R. and J. ALSTON (1990): elasticities in AIDS models. In: American Journal of Agricultural Economics 72 (2), 442-445.

HAGENAARS, A., DE VOS, K. and M.A. ZAIDI (1994): Poverty Statistics in the Late 1980s: Research Based on Micro-data. Office for Official Publications of the European Communities. Luxembourg.

HANSEN, G. (1993): Quantitative Wirtschaftsforschung. Vahlen, München.

HILL, H. and F. LYNCHEHAUN (2002): Organic milk: attitudes and consumption patterns. In: British Food Journal 104 (7), 526–542.

HUGHNER, R.S.; MCDONAGH, P.; PROTHERO, A.; CLIFFORD, J.S. and J. STANTON (2007): Who are organic food consumers? A compilation and review of why people purchase organic food. In: Journal of Consumer Behaviour 6, 94–110.

JONAS, A. and J. ROOSEN (2008): Demand for Milk Labels in Germany: Organic Milk, Conventional Brands and Retail Labels. In: Agribusiness 24 (2), 192–206.

LI, J.; ZEPEDA, L. and W. GOULD (2007): The Demand for Organic Food in the U.S.: An Empirical Assessment. In: Journal of Food Distribution Research 38 (3), 54–68.

LONG, J.S. and J. FREESE (2006): Regression Models for Categorical and Limited Dependent Variables Using Stata. Stata Press, Texas.

LZ Lebensmittel Zeitung (2005): Milchbauern warnen vor Nachahmern. In: Lebensmittel Zeitung 57 (14), 50. Deutscher Fachverlag GmbH, Frankfurt am Main.

MONIER, S.; HASSAN, D.; NICHÈLE, V. and M. SIMIONI (2009): Organic Food Consumption Patterns. In: Journal of Agricultural & Food Industrial Organization, Vol. 7. Special Issue: Quality Promotion through Eco-Labelling, article 12.

MOSCHINI, G. and D. MORO (1996): Structural change and demand analysis: a cursory review. In: European Review of Agricultural Economics 23 (3), 239-261.

PLAßMANN, S. and U. HAMM (2009): Kaufbarriere Preis? - Analyse von Zahlungsbereitschaft und Kaufverhalten bei Öko-Lebensmitteln. Final report of the research project 06OE119 of the German 'Bundesprogramm Ökologischer Landbau'.

RIEFER, A. and U. HAMM (2009): Veränderungen der Konsumintensität von Öko-Lebensmitteln in Haushalten mit Kindern. In: MAYER, J. et al. (ed.): Werte – Wege – Wirkungen: Biolandbau im Spannungsfeld zwischen Ernährungssicherung, Markt und Klimawandel. Conference transcript of the 10th Scientific conference 'organic farming', Vol. 2. Dr. Köster, Berlin, p. 324-327.

SHONKWILER, J.S. and S.T. YEN (1999): Two-step estimation of a censored system of equations. In: American Journal of Agricultural Economics 81 (4), 972-982.

SMITH, T.A.; HUANG, C.L. and B.-H. LIN (2009): Does Price or Income Affect Organic Choice? Analysis of U.S. Fresh Produce Users. In: Journal of Agricultural and Applied Economics 41 (3), 731–744.

THOMPSON, G.D. (1998): Consumer demand for organic foods: What we know and what we need to know. In: American Journal of Agricultural Economics 80 (5), 1113–1118.

THOMPSON, G.D. and J. KIDWELL (1998): Explaining the Choice of organic produce, cosmetic defects, prices and consumer preferences. In: American Journal of Agricultural Economics 80 (2), 277–287.

WICKENS, M.R. and T.S. BREUSCH (1988): Dynamic specification, the long-run and the estimation of transformed regression models. In: The economic journal 98 (390), 189-205.

WIER, M.; JENSEN, K.O.; ANDERSEN, L.M. and K. MILLOCK (2008): The Character of Demand in Mature Organic Food Markets: Great Britain and Denmark Compared. In: Food Policy 33 (5), 406–421.

ZEPEDA, L. and J. LI. (2007): Characteristics of Organic Food Shoppers. In: Journal of Agricultural and Applied Economics 39, 17–28.

ZHANG, F. HUANG, C.L.; LIN, B.-H and J.E. EPPERSON (2008): Modelling Fresh Organic Produce Consumption with Scanner Data: A Generalized Double Hurdle Model Approach. In: Agribusiness 24 (4), 510–522.

ZMP Zentrale Markt- und Preisberichtsstelle GMBH (2003): Bio-Frische im LEH. Fakten zum Verbraucherverhalten. Materialien zur Marktberichterstattung, No. 45. ZMP-Verlag, Bonn.