DETERMINANTS OF THE DEMAND FOR ORGANIC AND CONVENTIONAL FRESH MILK IN GERMANY– AN ECONOMETRIC ANALYSIS

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Abstract

An increasing number of studies deals with consumer decisions regarding organic food, but only a few provide quantitative estimates of price and income elasticities. This paper contributes to the existing literature by providing own-price elasticity estimates as well as an analysis of the sociodemographic determinants of demand for organic milk. The analysis is based on the *GfK Consumer Scan* Scanner panel dataset on food purchases of German households covering a sample period of four years from 2004 to 2007. A two-step estimation procedure is applied. First, a probit regression examines which household characteristics affect the probability to buy organic milk. Second, a fixed-effects panel regression determines factors that have an impact on the quantity demanded. Finally, the study investigates whether the price elasticity of demand depends on income, age or household size and whether the price elasticity varies among different retail formats.

The results show that the probability to buy organic milk increases with education and income level. Furthermore, the demand is on average higher in households with young children and with a female being mainly responsible for food purchases. However, the probability declines when there is more than one child per household.

The results of the fixed-effects regression indicate that the demand for organic milk in Germany is highly price-inelastic. Low absolute price elasticities for organic milk indicate that price promotions at retail level will not lead to an increase in sales.

As expected, for all types of milk price sensitivity is higher, but still inelastic, in discount shops than in other retail formats such as supermarkets or large-scale retail. Demand in organic food shops is the least responsive to price changes. Besides, households headed by a person younger than 25 or older than 45 years show a higher price responsiveness than middle-aged households.

Keywords: Organic milk, Household Panel, Probit Analysis, Fixed-Effects-Panel Analysis, Price elasticity, Private-labels, Germany

JEL codes : C23, C24, C25, D12, M31, Q11

1 Introduction

In the early stage of introduction of organic milk in Germany as well as in the U.S., predominantly labeled products existed which were mainly sold by direct sales or in speciality stores. According to CHOI and WOHLGENANT (2010, 5) the competitive structure of the U.S. organic milk market has considerably changed due to market expansion over the last years. By now, there are not only several national and local brand organic milk products but also private-label organic milk promoted by supermarkets and discounters. Exactly the same development took place in Germany. Nowadays, nearly every discounter and supermarket offers both organic and conventional milk. Often consumers can additionally choose between at least one brand product and a private-label. Given this background, the objective of the study is to analyze the demand for organic and conventional milk in Germany, distinguishing both between organic and conventional milk and between private-label and brand products.

As the organic milk market grows and the range of organic milk products becomes more and more diversified, it is increasingly important to get to know the organic milk consumer. Obtaining insights in consumer purchasing behaviour is essential, especially for producers, manufacturers and retailers of organic food, in order to plan production, to design products, to set prices and to gain market shares.

Most of the previous studies in this field analyzed attitudes regarding organic food rather than actual purchase decisions. Using survey data or experimental methods, these studies typically elicit willingness to pay (see e.g., AKAICHI et al. 2010; BEHARELL and MACFIE 1991; FRICKE 1996; MISRA et al. 1991; TAGBATA and SIRIEIX 2008; ZMP 2003) or the attitudes towards organic milk products (see e.g. HARTMAN GROUP 2006; HUANG 1996; JOLLY 1991; WILLIAMS and HAMMITT 2000; ZEPEDA and LI 2007). However, research has provided evidence that there is a considerable discrepancy between consumer attitudes towards organic food and their actual purchase behaviour (e.g., FRYKBLOM 1997; RODDY et al. 1996). This discrepancy necessitates the use of real purchase data in order to characterize organic consumer behaviour.

This study contributes to the current body of literature by using actual purchase and demographic data to analyze both, the factors that influence the likelihood of buying organic milk and the factors determining the quantity demanded. Thus, the understanding of the German organic milk consumers is expanded. Additionally, the analysis provides detailed estimates of price elasticities for several socioeconomic groups and for different retail formats, an aspect neglected in previous research. This differentiation does not only allow providers of organic and conventional milk to customize and individualize their price policy but also politicians to establish market conditions that enhance the growth of the organic milk market.

2 Literature review

There are two different branches of organic food research that are relevant and 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.

2.1 Organic food consumer profile

There is evidence that organic food consumer profiles differ with respect to the commodity group investigated (see e.g., ZMP 2003). However, research on the sociodemographic characteristics that focuses just on organic milk consumers is scarce. Therefore, in this paper, results

of studies analyzing the characteristics of organic food consumers in general are presented and will be later on used as a basis for comparison with the organic milk consumer profile (see chapter 5.1).

Scientific answers to the question 'Who is the organic food consumer?' are really multi-faceted 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 and SKEES 1994; DETTMANN and DIMITRI 2010; GOVINDASAMY and ITALIA 1999; HUGHNER et al. 2007; SMITH, HUANG and LIN 2009; THOMPSON 1998). But results are not clear: THOMPSON (1998, 1113ff), for example, finds evidence that not only households with higher **income** are more likely to purchase organic food but also a special consumer group with relatively low income. Moreover, MONIER et al. (2009) and LI et al. (2007) do not detect a significant correlation between income and the demand for organic food at all.

Results concerning the impact of **age** on the probability to buy organic food are again conflicting. On the one hand, JONAS and ROOSEN (2008) and BRUHN (2002), who analyze the German organic food consumers, state that the probability to buy organic food increases with age. On the other hand, the ZMP (2003, 26f) as well as PLAßMANN and HAMM (2009, 67f) do not find a significant correlation between age and buying propensity.

There is a general consensus on the impact of **educational attainment**. The majority of studies show a positive relationship between educational attainment and the household's market participation and consumption of organic food (see e.g., MONIER et al. 2009; SMITH, HUANG and LIN 2009; WIER et al. 2008; ZEPEDA and LI 2007; ZHANG et al. 2008).

Concerning **household size** most of the studies for the U.S. as well as for France and Germany point out that there is no close connection with the preference for organic food (e.g., MONIER et al. 2009; THOMPSON 1998; ZMP 2003). Organic food and especially organic milk seem to have an above-average importance in families with **young children** (e.g., SMITH, HUANG and LIN 2009; ZMP 2003). HILL and LYNCHEHAUN (2002, 530) work out that in many families pregnancy and childbirth mark the beginning of organic food consumption. From this moment on, parents pay more attention to their food choices. The impact of **elderly children**, however, is not clear. Analyses of HUGHNER et al. (2007, 96ff) and THOMPSON and KIDWELL (1998) indicate that children, irrespective of their age, increase the probability to choose organic food. While several studies do not find a significant influence of elderly children (e.g., SMITH, HUANG and LIN 2009; WIER et al. 2008), others even observe a negative impact on the demand for organic food (e.g., JONAS and ROOSEN 2008). RIEFER and HAMM (2009, 325) ex-

plain this finding as follows: When children get older, their food preferences differ more and more from those of their parents. Because buying decisions are increasingly adjusted to the requirements and wishes of the children, this can lead to a return to conventional food.

To summarize the hitherto existing results it can be noticed that a general characterisation of the organic food consumer and general conclusions about his shopping behaviour can not be drawn. In fact, findings regarding consumer profile and behaviour seem to depend strongly on date, region and methods of the study as well as the commodity group and the sample. Therefore further research specifying explicitly these influencing factors is required.

2.2 Demand elasticities for organic milk

Although econometric analyses that examine demand elasticities for the German organic food and organic milk market are scarce, there are some studies which can be used as a basis for comparison. Thus, GLASER and THOMPSON (2000) as well as CHOI and WOHLGENANT (2010) analyze the U.S. organic milk market, while MONIER et al. (2009) focus on the French and JONAS and ROOSEN (2008) on the German organic milk market.

GLASER and THOMPSON (2000) analyze the demand for organic and conventional milk in the U.S. in the period from 1988 to 1999 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. For conventional private-label milk and brand milk the authors find price elasticities of -0.66 and -0.73, respectively. According to their study, demand for organic milk is highly price-elastic (-3.64). Since organic milk price is higher than brand milk price which again is higher than private-label milk price, the authors conclude that consumers react the more elastic to price changes the higher the price level of the milk product is (GLASER and 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 indicate that organic milk consumers are highly price sensitive and that food retailers consequently face a really constrained price setting potential.

DHAR and FOLTZ (2005) and ALVIOLA and CAPPS (2010) both use 2004 U.S. Nielsen Homescan Panel data. DHAR and FOLTZ (2005) investigate demand interrelationships for rBST- (bovine growth hormone) free milk, organic milk and private-label conventional milk for 12 U.S. cities. They find own-price elasticities for organic and conventional milk to be -1.4 and -1.0,

respectively. ALVIOLA and CAPPS (2010) present elasticity estimates of -0.87 for conventional milk and of -2.0 for organic milk.

Hence, a consolidated view of previous studies indicates that demand for organic milk is much more elastic than demand for conventional milk. The same is true for organic food as a whole: The majority of studies that compare price elasticities for conventional products with those of their organic counterparts indicates that demand for organic food is much more elastic than demand for conventional food (e.g., GLASER and THOMPSON 2000; JONAS and ROOSEN 2008; LIN, YEN and HUANG 2008; WIER and SMED 2000).

Two exceptions are the studies of MONIER et al. (2009) and of CHOI and WOHLGENANT (2010). In contrast to the studies presented above, price elasticity estimated by MONIER et al. (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 on a very disaggregated level applying a two-step demand system approach. In this study 20 milk types are defined by three different characteristics: fat content (four different fat contents plus soy milk are distinguished), flavoured or not and organic claim. The results indicate an elastic demand both for organic and conventional milk.

These studies seem to be only partly comparable to this paper. Corresponding with this paper, all of the presented studies use panel data and analyze the milk market at a disaggregated level by distinguishing at least two milk types – organic and conventional milk. However, data are often outdated. Using data that are at least six years old, previous studies describe the organic milk demand in earlier stages. Since size and structure of the organic market has changed considerably – in the U.S. as well as in Europe – they can hardly account for the current market analysis.

To conclude: Results concerning the price sensitivity of milk consumers are quite heterogeneous. Especially the magnitude is not clear. Several studies seem to find similar price elasticities for conventional milk in the range from -0.1 to -1.0, whereas estimates for organic milk show a really wide range of variation from -0.4 to -10.2.

The missing differentiation between private-label and brand organic milk as well as between different groups of consumer households and different retail formats in existing studies reveals that there are still research deficits with regard to organic (milk) consumers' behaviour. The empirical part of this article will provide some new insights into these issues.

3 Data and sample description

This analysis is based on the *GfK Consumer Scan* Scanner panel dataset on food purchases of German households covering a sample period of four years from the first week in 2004 to the last week in 2007. The dataset records grocery purchases of 20,000 households[1] from a wide variety of retail outlets including direct sales and speciality shops.

Comprising detailed information for each milk purchase like date of purchase, amount bought, actual price, brand chosen, name of the supermarket chain, fat content and organic claim, the dataset offers an ideal basis for this kind of analysis. Additionally, the dataset includes sociodemographic variables such as information about age, education, profession and sex 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.

Figure 1 plots the percentage changes of weekly expenditures for conventional and organic fresh milk in Germany (first week in 2004 = 100 %). It illustrates the enormous growth of the organic milk market. While expenditures on organic fresh milk increased by almost 200 % within four years, the spending on conventional fresh milk stagnated. Prices for conventional and for organic milk have been quite stable from 2004 until the beginning of 2007. Since the second quarter in 2007 they rose rapidly. Thus, the growth in sales of organic milk can be attributed both to an increase in quantity and in prices.

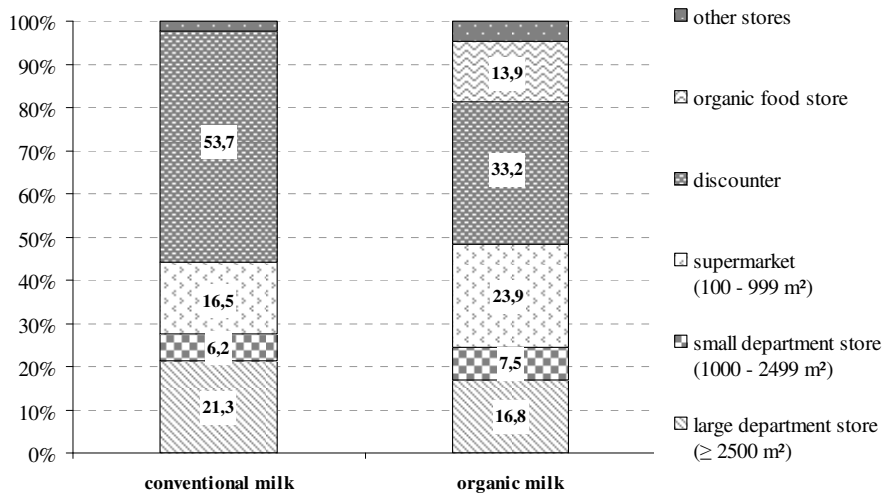
Figure 1. **Development of the weekly expenditures for conventional and organic fresh milk in Germany, 2004-2007**

In this paper, consumer responsiveness to price changes is analyzed separately for different retail formats. Therefore, it is important to become acquainted with the market prominence of several retail formats. Figure 2 illustrates the percentage share of sales for large (> 2,500 m²)

[1] The households in the GfK panel dataset 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.

and small (1,000-2,500 m²) department stores, supermarkets (100-999 m²), discounters and organic food stores[2]. Apparently, discounters are the most important retail outlet both in the market for organic (33 %) and conventional milk (54 %). Regarding organic milk, supermarkets and large scale retail stand for approximately one quarter of sales, respectively. Although their market share is decreasing, the role of organic food shops (14 %) should be kept in mind.

Figure 2. **Percentage share of sales of different retail formats for conventional and organic milk in Germany, 2007.**



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[3].

In order to illustrate the development of the individual milk types with regard to their market penetration, table 1 shows the percentage shares of user households for the different milk types over time. User households are defined as households that made at least one purchase within a year. While the market penetration of the conventional milk types declined slightly, the percentage of households buying organic milk increased. Thereby OPL milk expanded its penetration faster than OB milk: In 2004, both organic milk types were bought by about 5 % of German households. Until 2007, the percentage of households buying OB milk rose slightly to 6.7 % whereas the percentage buying OPL milk almost doubled to 11.6 %.

[2] Retail formats are defined following the classification of the Nielsen Company for German food retailing.

[3] Studies analyzing the U.S. milk market often distinguish additionally between different fat contents, flavours or packaging sizes (e.g. CHOI and WOHLGENANT 2010; GLASER and THOMPSON 2000). In this paper milk types are only classified on the basis of two criteria (organic/ conventional and brand/ private-label) in order to reduce the percentage of zero observations. Furthermore, in Germany fat contents and packaging sizes of milk are not that strongly differentiated as in the U.S.: Milk is almost solely sold in one-liter-cartons (89-100 %, depending on milk type) and without a special flavour. The majority of organic milk has a natural fat content of more than 3.8 % (source: own computation).

Table 1. **Percentage shares of user households for different milk types in Germany, 2004-2007.**

Milk type	2004	2005	2006	2007
Organic brand milk (OB)	4.8	5.4	6.0	6.7
Organic private-label milk (OPL)	5.7	5.7	9.3	11.6
Conventional branded milk (CB)	65.4	62.1	61.0	62.3
Conventional private-label milk (CPL)	96.9	97.2	97.3	96.4

The sample consists of 20,544 milk consuming households. Table 2 provides information on the sample demographic distribution. The average weighted per-capita income[4] is about 1,350 Euro, the average household size is 2.2. The majority of households is of German nationality (93 %) and lives in the South (34 %). In 64 % of the reporting households a female person is mainly responsible for food purchases. In 56 % the household head is employed or self-employed. 39 % of household heads are in the age between 30 and 49. On average, households spent 2.8 % of their food budget on organic products and 2.6 % of their milk budget on organic fresh milk.

Furthermore, table 2 displays sample means and household characteristics for the different milk user groups. Used as the first-step discrete dependent variable, an user household of a certain milk type is again defined as a household that made at least one purchase of the relevant milk type during one year. The first-step decision is analyzed based on annual data, resulting in a sample of 77,578 observations.

Comparing demographic information across user groups, table 2 shows that organic milk users have on average a larger net income than conventional milk users. Moreover households buying brand milk – both organic and conventional – have a larger net income than those buying private-labels. These results do not surprise bearing in mind that organic and branded products command a price premium compared to non-organic products and private-labels, respectively (LIN, SMITH and HUANG 2008).

With respect to the budget shares of organic food and milk there are great differences between user groups. Expenditures on organic food in general averaged on 11 % for households buying OPL milk (15 % for households buying OB milk) but only 3 % for households buying CB or CPL milk. These figures support the assumption that households buying organic milk also spend a larger part of their budget on organic food products in general. Moreover, organic milk and CB milk seem to be substitutive goods: Households buying CB milk show an above-average budget share of organic milk and vice versa.

[4] Household's net income was received by taking the mean of the reported income group. In order to get a per-capita income, household income was adjusted for the number of household members weighted by the new OECD scale. In the following I refer to this weighted per-capita net income when talking about income.

Table 2. **Sample Means of Milk Expenditures and Household Characteristics by User Groups in Germany, pooled data for 2004-2007[a)]**

Variable	Whole sample	User groups of different milk types			
		OB	OPL	CB	CPL
Metric Variables (Sample Means)					
Net income [b)] (in Euro)	1349.11	1508.05	1483.10	1377.37	1345.00
Household size	2.18	2.18	2.19	2.20	2.20
Number of Children under 18 years	0.40	0.39	0.39	0.38	0.40
Nationality and Gender (% of the Sample)					
German nationality	92.74	91.28	90.81	93.24	92.67
Female person	63.56	65.68	64.91	64.45	63.41
Budget Shares (Sample Means in %)					
Organic food of food expenditures	2.82	14.74	10.98	3.37	2.70
Organic branded milk of milk expenditures	1.23	21.41	7.48	1.95	1.01
Organic private-label milk of milk expenditures	1.41	10.33	17.52	1.92	1.32
Conventional branded milk of milk expenditures	22.68	27.53	29.12	36.16	20.72
Conventional private-label milk of milk expenditures	74.68	40.72	45.88	59.97	76.94
Region (% of Sample)					
West	27.92	20.78	26.45	25.90	28.13
East	18.60	9.55	10.65	21.23	18.52
North	19.36	18.91	19.32	17.20	19.56
South	34.12	50.76	43.58	35.67	33.79
Urbanisation (% of Sample)					
Others (no large city)	74.88	76.96	79.09	73.81	74.94
Large city (more than 100,000 inhabitants)	33.92	35.57	38.66	32.83	33.95
Kids (% of Sample)					
Kids between 0 and 6 years	9.77	12.21	11.60	9.42	9.97
Kids between 7 and 14 years	14.51	12.03	12.95	14.02	14.80
Kids between 15 and 18 years	8.77	7.12	7.60	8.86	8.88
Education (% of Sample)					
Hauptschulabschluss [c)]	26.90	19.40	19.82	26.24	26.93
Realschulabschluss [d)]	29.78	24.52	26.05	29.14	29.83
Highschool diploma	21.65	25.84	24.06	21.80	21.69
University degree	21.66	30.24	30.07	22.81	21.54
Age (% of Sample)					
< 30 years	10.76	9.53	8.61	9.70	10.90
30-49 years	39.21	40.25	38.66	37.56	39.45
50-69 years	33.68	36.12	35.80	35.55	33.56
> 70 years	16.35	14.10	16.93	17.18	16.09
Profession (% of Sample)					
Employees & Public servants	37.55	46.12	43.20	36.76	37.69
Workers & Apprentices	13.66	7.28	8.38	13.12	13.75
Freelancers & Self-employed persons	4.28	5.39	4.49	4.39	4.24
Housewives, Pensioners & Students	39.43	38.00	40.66	41.01	39.20
Farmers	0.09	0.04	0.00	0.09	0.09
Jobless persons	4.99	3.11	3.23	4.62	5.02
No. of observations	77,578	4,428	6,248	48,634	75,206
% of observations	100.00	5.71	8.05	62.69	96.94
No. of households	20,544	1,918	2,830	15,514	20,226

Note: Here an user group is defined as those households which decide to purchase a certain milk at least once a year. Consequently a household can be a member of more than one user group.

[a)] The sample means are computed as weighted averages by applying sampling weights reported in the GfK Homescan data to ensure the sample statistics reflect a more accurate representation of the German population.

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

[c)] German school-leaving certificate usually taken after the fifth year of secondary school.

[d)] German school-leaving certificate usually taken after the sixth year of secondary school.

Organic milk users tend to live in the South, whereas households preferring conventional milk concentrate in the eastern parts of Germany. A higher proportion of organic milk users, especially of those buying OPL milk, live in large cities with more than 100,000 inhabitants. Besides income effects, this finding could be caused by the fact that households located closer to central business districts have a better access to organic food or may be more aware of healthy eating (SMITH, HUANG and LIN 2009, 740).

About 12 % of organic milk users have young children, compared to less than 10 % among households buying conventional milk types. On the other hand, the percentage of households having children in the age between 7 and 18 years is higher among conventional milk buyers. Similarly, the average household size is higher in households buying conventional milk. The existence of children probably lowers the per-capita income and consequently strengthens the price consciousness of the households.

Considering educational attainment, most organic users have a university degree. In contrast, members of the conventional milk user groups are most likely to have only the German "Realschulabschluss" – a school-leaving certificate usually taken after the sixth year of secondary school that allows for starting an apprenticeship or for attending upper school.

The age of the household head does not seem to have a remarkable impact on the household's decision whether to buy organic milk or not. The age distribution is nearly the same for all considered user groups. With respect to profession, table 2 reveals that employees and public servants represent a higher, workers and jobless persons a lower, proportion of the organic milk users than of the conventional milk users. This result is surely correlated to the average income within these professional categories.

4 Methodological approach

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. Applying the double hurdle model originally introduced by CRAGG (1971), 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)[5]. Each of the household's decisions is determined by a different set of explanatory variables. In a first step, a probit regression examines which de-

[5] Using CRAGG's (1971) independent double hurdle model it is assumed that shocks to the participation process (first step) are independent from those to the consumption process (second step). It is often criticized that this assumption is not realistic for the organic food market because hidden factors such as availability exclude potential organic consumers from making actual purchases in the first place (ZHANG et al. 2008, 512). Because organic milk by now is available in almost every shop, it is hence considered to be available to all consumers.

terminants influence the purchase probability. The second-step decision is analyzed by means of a censored regression model. For each milk type *i*, the first-step decision is modelled as

$$(4.1) \quad \Pr_{iht}\left\{ user\ household = 1 \right\} = X_{iht}^{'}\beta_i + u_{iht} \quad \text{where} \quad u_{iht} \left| X_{iht} \sim N(0,1). \right.$$

$X_{iht}^{'}$ is the vector of independent variables for household *h* in year *t*. β represents the corresponding coefficients associated with $X_{iht}^{'}$. The independent vector contains discrete variables describing the place of residence (*region)*, age (*age*), educational attainment (*education*) and profession (*profession*) of the household head, net income (*income*), number of children (*kids18*) as well as dummy variables for German nationality *(*D_{nation}*)*, for location in large cities with more than 100,000 inhabitants (D_{city}), for gender *(*D_{gender}*)*, for single households (D_{single}) and the presence of children under seven years (D_{kids07}). In contrast to most extant studies, this analysis accounts for the panel structure of the data. Therefore, it is possible to allow for household-specific heterogeneity and habit formation by incorporating past consumption decisions, i.e., the demanded quantity of the respective milk type in the previous year (*habit formation).*

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 premium*s can be assumed to play an increasingly important role in consumers' decision to purchase organic or conventional milk (SMITH, HUANG and LIN 2009: 735). The price premiums of OB, OPL and CB milk are computed as the percentage above the average price of CPL milk[6]:

$$(4.2) \quad price\ premium = \frac{p_{iht} - \overline{p}_{CPL,t}}{\overline{p}_{CPL,t}} \ ,$$

with p_{iht} = average price paid for milk type *i* by household *h* in year *t*
$\overline{p}_{CPL,t}$ = average price of conventional private-label milk in year *t*.

The respective *price premium* is also incorporated as an explanatory variable. The market participation decision is hence modelled as a function of sociodemographic variables, past

[6] Panelists of the *GfK Consumer Scan* do not report exact prices but total quantity and expenditures for each food they bought. So 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 and WOHLGENANT 1986). A second problem connected with 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 the average of the reported unit values has to be used as an approximation for the prices of milk types that the household did not purchase.

consumption and price premium. Due to the fact that information on sociodemographic characteristics - which are assumed to be the main determinants of the market participation decision - is collected only once a year, the first-step decision is modelled on an annual data base. Thus, Equation (4.1) is estimated for H=19,066 households and T=3 years[7].

In the second step, a nonrandom sample occurs since the individual subpopulations drawn from the larger random population consist of households that actually purchased a certain milk type. To correct for sample selection bias in the second-step a fixed-effects panel model (FEM) is applied which takes into consideration that the assumption of random effects – error terms are neither correlated over time nor over households – does not hold (FENDEL 2004, 738). The choice of a FEM was verified by significant Hausman tests. In contrast to previous studies which applied demand systems, in the majority of cases the Almost Ideal Demand System (AIDS, e.g., GLASER and THOMPSON 1998, 2000; JONAS and ROOSEN 2008; MONIER et al. 2009), this study uses single equations to estimate consumer's price sensitivity. Although demand systems impose the theoretical restrictions of demand theory, research has provided evidence "that none of the existing models perfectly define demands and measure elasticities" (CHOI and WOHLGENANT 2010, 8). Thus, it is important to compare elasticity estimates for organic milk based on different estimation methods.

The second-step dependent variable is the weekly per-capita demand for the respective milk type. A linear demand function for milk type *i* can be expressed in general form as

$$(4.3) \quad q_{iht} = \alpha_i + \beta_i p_{it} + \sum_j \gamma_{ij} p_{jt} + \delta_i y_{ht} + \sum_m \varepsilon_{im} X_{mht} + u_{iht}$$

with
- q_{iht} = per-capita demand for milk type *i* in household *h* in week *t*
- p_{it} = own-price of good *i* in week *t*
- p_{jt} = price of milk type *j* (j ≠i) in week *t*
- y_{ht} = per-capita income in household *h* in week *t*
- X_{mht} = sociodemographic characteristic *m* of household *h* in week *t*.

The subscript *i* denotes the good (i.e. the milk type), *h* the household and *t* the time. The subscript *j* stands for different complementary and substitutive goods while *m* describes several household characteristics. Besides the own-price p_i, prices of complementary and substitutive milk types p_j, income *y* and further sociodemographic characteristics X_m are incorporated in the second-step model. β, γ, δ und ε are estimation parameters and α is the constant term. The expected value of the error term *u* is normally distributed.

[7] Because of the dependence on lagged consumption the sample period shortens. Consequently the probit model is estimated for the years 2005-2007.

To prevent multicollinearity, the demand equation is estimated as a per-capita-model[8]. Furthermore, monetary variables are expressed in real terms. Because demand for organic milk has increased considerably during the sample period, a *trend* is included. To account for habit formation the sum of per-capita-demand in the previous quarter (12 weeks) is incorporated as an additional explanatory variable. In order to cope with seasonal patterns of demand, seasonal dummy variables (D_{Saison}) enter the equation, whereupon autumn serves as baseline category. The vector of sociodemographic variables comprises the number of children (*kids18*) and a dummy for the existence of young children in the household (D_{kids07})[9].

A common problem with consumption data is, that the distribution of the dependent variable is highly skewed, with most consumers demanding small amounts (e.g., YEN and HUANG 1996; YEN and JONES 1997; ZHANG et al. 2008, 514). Since econometric models like double hurdle are only valid if the dependent variable is normally distributed, the natural logarithm of per-capita consumption is used as dependent variable[10].

Testing several forms of demand function, a double logarithmic functional form provided the best estimates with regard to the plausibility of results and the goodness-of-fit measures ($\bar{R}^2$-value, F-value, p-values). Moreover, this form is really comfortable because the double log structure allows interpretation of the coefficients as elasticities (RAMANATHAN 1995, 257). The final specification of the demand function is given by equation (4.4). The model is estimated based on weekly data for H = 49,677 individual households and T = 198 weeks[11].

$$\begin{aligned}\ln q_{iht} = {} & \alpha_i + \beta \ln p^r_{iht} + \gamma_1 \ln p^r_{s1t} + \gamma_2 \ln p^r_{s2t} + \gamma_3 \ln p^r_{s3t} + \delta \ln y_{ht} + \varepsilon_1 kids18_{ht} \\ & + \varepsilon_2 D_{kids07,ht} + \varepsilon_3 \sum_{n=1}^{12} q_{ih,t-n} + \xi_1 t + \xi_2 D_{spring} + \xi_3 D_{summer} + \xi_4 D_{winter} + u_{iht}\end{aligned} \tag{4.4}$$

with
- q_{iht} = per-capita demand for milk type *i* in household *h* in week *t*
- p_{iht}^r = own-price of milk type *i,* which is paid by household *h* in week *t* (in real terms)
- p_{st}^r = respective price of the three other milk types in week *t* (in real terms)
- y_{ht}^r = net income (equivalent household disposable income) of household *h* in week *t* (in real terms)
- $q_{ih,t-n}$ = weekly per-capita demand for milk type *i* in household *h* in week *t-n*
- $kids18_{ht}$ = number of kids (<18 years) living in household *h* in week *t*
- t = trend
- $D_{kids07,ht}$ = dummy variable for children < 7 years in household *h* in week *t*
- D_{season} = several seasonal dummy variables (spring, summer, winter)
- u_{iht} = error term.

[8] Following DEATON (1986, 1801f) it was tested whether there are economies or diseconomies of scale to household size in the consumption of (organic) milk. Because constant returns to scale were found, per-capita consumption was computed as the quotient of household consumption and household size, without any weighting of household members.

[9] All other sociodemographic variables were removed from equation either because their impact was not significant or because they were highly correlated with income. It was also tested for non-linear or combined effects of sociodemographic variables.

[10] Appendix 1 shows the histograms of original and transformed data verifying that the natural logarithm is more likely to be normally distributed.

[11] Again the sample period shortens because of the dependence on lagged consumption. Consequently the truncated regression in equation (4.4) exclude the first 12 weeks in 2004.

Finally, the demand function specified in equation (4.4) is estimated separately for several subsamples. This proceeding results in elasticity estimates for different retail formats and different household groups.

5 Results

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 and TRIVEDI 2009, 462). To allow for a more meaningful interpretation, elasticities with respect to market 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 market participation decision, i.e. $\partial P(y>0)$, are reported.

The results reveal a strong impact of sociodemographic characteristics on consumers' purchase decisions. Among all discrete variables income and education have the highest probability marginal effects on the market participation decision. The higher the *income* and the higher the *educational attainment*, the more likely is the household to buy organic (OB and OPL) milk 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) 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.

Furthermore, those households where a female person is key household shopper, those of other nationality than German, those living in large cities and those 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 effect of the *age* of household head on organic milk market 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). Admittedly, the probability to buy milk in general (i.e. CPL milk) clearly declines with rising age. 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 each by about 0.03 relative to households located in the west. However, the probability to buy OPL milk decreases by 0.02 for households located in the newly formed German states relative to those in the west.

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 premiums

		%	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	b	b	b	b
	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	Hauptschulabschluss	26.0	b	b	b	b
	Realschulabschluss	31.2	-0.0012	0.0081	0.0079	-0.0008
	highschool diploma	21.3	0.0163***	0.0251***	0.0061	-0.0021
	university degree	21.5	0.0266***	0.0486***	0.0217**	-0.0027
age	< 30 years	8.3	b	b	b	b
	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	b	b	b	b
	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	b	b	b	b
	others	7.0	0.0104*	0.0150*	0.0159	0.0030
urbanisation (D_{city})	others	67.4	b	b	b	b
	large cities	32.6	0.0076**	0.0166***	0.0066	0.0026**
single households (D_{single})	multi-person household	79.0	b	b	b	b
	single household	21.0	0.0042	-0.0005	-0.0175**	-0.0057***
Number of children (<18 years) *(kids18)*	no child	68.6	b	b	b	b
	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 unter 7 years	85.7	b	b	b	b
	children under 7 years	14.3	0.0276***	0.0305***	0.0308***	0.0002
Gender (D_{gender})	male	35.1	b	b	b	b
	female	64.9	0.0099***	0.0092**	-0.0105*	-0.0039***
place of residence *(region)*	west	26.2	b	b	b	b
	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)			39,516	39,516	39,516	39,516
N (No. of households)			19,066	19,066	19,066	19,066
Log Likelihood Value			-7,235	-10,077	-21,968	-4,226
Chi²			3,991	4,273	7,920	1,554
Likelihood Ratio χ^2 (p)			0.000	0.000	0.000	0.000
McFadden's Adj. R²			0.183	0.156	0.119	0.109
Adj. Count-R²			0.158	0.145	0.085	0.000

Note. ***, **, * and (*) denote significance at 0.1, 1, 5 and 10 %, respectively.

a) Probability marginal effect is reported for discrete variables and denotes absolute change in organic milk market 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 market participation probability in response to the percentage change in continuous variable.

As expected, *prices* and *habit formation* are very important determinants of consumer's organic milk market participation. 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 is lower by 0.3 %. Interestingly price premiums show a higher impact on the market 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 market participation, respectively.

5.2 Fixed effects regression

Section 5.2.1 presents the second-step estimation results for the whole sample. Section 5.2.2 shows a more detailed analysis for different household groups and different retail formats.

5.2.1 Pooled regressions for all households and retail formats

With regard to the second-step estimation results, this paper focuses on price and income elasticities. Therefore, the computed elasticities will be discussed profoundly. A complete table showing the coefficients of all variables included in the second-step model is provided in appendix 2. Table 4 compares elasticity estimates of this study to those of previous studies presented in chapter 2.2. It is striking that previous studies rarely achieved significant price elasticity estimates. This is possibly caused by considerably smaller sample sizes.

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 the first and the last-mentioned findings, i.e., demand for conventional milk seems to be inelastic. Furthermore, price sensitivity does not differ substantially between brand and private-label milk, neither for conventional nor for organic milk. But the second can not be confirmed. The estimation results of the present study indicate a highly inelastic demand for organic milk, both for OB milk (-0.11) and for OPL milk (-0.10). The dissimilarity in the magnitude of own-price elasticity estimates of this study in comparison to the previous studies – especially the ones of GLASER and THOMPSON (-3.6) and JONAS and ROOSEN (-10.2) – demands a closer look.

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/ WOHL-GENANT (2010)	Own results (2010)
sample period	1989 - 1999	2004	2000-2003	2005	2004	2004/ 2005	2004 - 2007
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(*)	-0.62***
CPL milk	-0.66**		-1.01*				-0.58***
OB milk	-3.64	-1.37***	-10.17*	-0.38	-2.00***	-1.91	-0.11***
OPL milk							-0.10**
income/ expenditure elasticity							
CB milk	1.16**e)	0.97***	0.99*e)	---	-0.01i)	0.75(*) e)	0.03***i)
CPL milk	1.00**e)		1.04*e)	---			0.01**i)
OB milk	-5.73*e)	0.50***	0.73*e)	---	0.27* i)	0.60e)	0.01i)
OPL milk				---			0.03i)

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.

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, both the panel data used by JONAS and ROOSEN and by GLASER and THOMPSON do not report purchases in organic food shops[12], where consumer price sensitivity is naturally lower than in other retail formats[13]. Second, the sample period differs. GLASER and THOMPSON (2000, 15), who estimated demand elasticities separately for several time periods between 1989 and 1999, found that price elasticity for organic milk declined over time, whereas price elasticities for CB and CPL milk remained constant. Third, in this study single demand equations are applied while the other studies presented make use of Almost Ideal Demand Systems (AIDS; see DEATON and MUELLBAUER 1980). It is a well-known fact that AIDS tends to overestimate elasticities if expenditure shares of the considered commodities are quite small (GLASER and THOMPSON 2000, 17), which is certainly true for organic milk.

Thus, taking into account that the database of this study is more recent and also includes purchases in organic food shops and that single demand equations are applied, it seems plausible that price elasticities for organic milk (in absolute values) are smaller. Furthermore, it is not surprising that demand for organic milk is less elastic than demand for its conventional coun-

[12] CHOI and WOHLGENANT (2010) who use AC Nielsen Homescan data from 2004 to 2005 do not explicitly state whether purchases in organic food shops are included in the sample or not.
[13] Because of this limitation the data base of JONAS and ROOSEN (2008), the GfK Homescan panel 2000 to 2003, represents only 36 % of the organic turnovers. Assuming that consumers who buy organic milk 'out of 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.

terpart. It is often underlined that organic products are bought 'by conviction'. Product and process quality, freshness and freedom from pesticides are central buying motives. For those consumers who have in the first step already decided to buy organic milk, prices do not seem to play an important role. 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 UHT milk or to milk with another fat content is not possible within one place of purchase.

Only the study of MONIER et al. (2009) finds an inelastic demand for organic milk (-0.4). However, there are analyses of further organic food markets presenting similar results. Thus, ZHANG et al. (2006) find that demand for organic vegetables is less elastic than that for conventional vegetables. ANDERS and MÖSER (2008, 464), who examine the demand for value-based organic meats in Canada, state that there are no considerable differences in the magnitude of elasticities between organic and conventional meat products. And RIPPIN (2008, 69) observes that price campaigns for organic products do not cause as high incentives to buy as for conventional products.

The estimated income elasticities of this study are positive for all milk types. Considering milk to be a superior good, this result is plausible. However, the magnitude of income elasticity is again considerably lower than in previous studies (cf. table 4). Once a household has decided to buy organic milk, income has scarcely any effect on the quantity demanded.

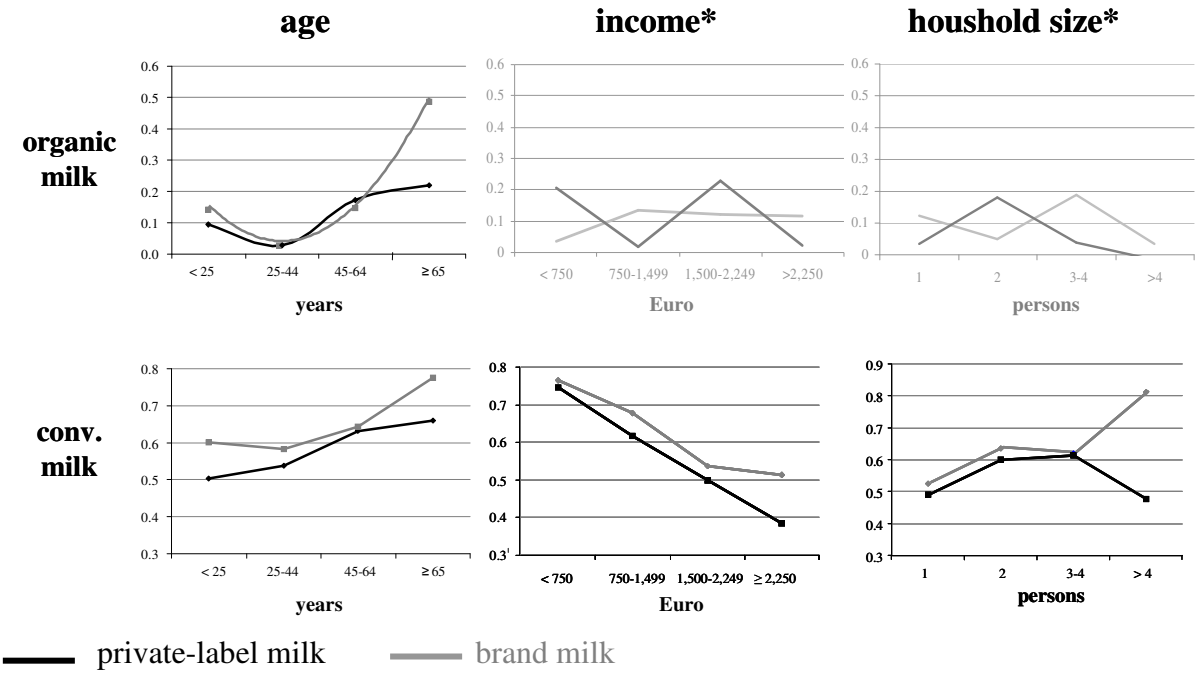
5.2.2 Differentiation between household characteristics and places of purchase

The analysis of individual household groups focuses on groups with a rising share of the population. In future, demographic aging (EUROPEAN COMMISSION 2008), a wider distribution of income (BMAS 2008, 65) and a higher share of single households (STBA 2006) will modify German population structure. Accounting for these trends, elasticities are estimated separately for different age and income groups and for different household sizes. Results are presented in figure 3.

To the best of the author's knowledge, so far there are no elasticity estimates for separate household groups with respect to organic food or organic milk. Therefore, results are compared to those for conventional milk. PARK et al. (1996) do not find significant differences in price elasticities for milk between poor and non-poor households in the U.S. According to THIELE (2008, 264), however, poorer households, single households and elderly households respond more elastically to milk price changes compared to average households in Germany.

Concerning age and income, this study confirms THIELE's and disagrees with PARK's findings. Both for conventional and for organic milk, households headed by a person older than 64 years show the highest price responsiveness (cf. figure 3, column on the left). But only for conventional milk price elasticity rises continuously with age. For organic milk, a j-shaped relationship between age and price elasticity is observed, i.e. price responsiveness is higher in households with a household head younger than 25 or older than 64 years than in middle-aged households. Presumably, younger households often have to pay more attention to prices due to budget constraints. In households with a retired household head two explanations for higher price responsiveness are imaginable: On the one hand, elderly persons often live very frugally due to war experiences and constrained agility. On the other hand, time available for price comparisons is higher enabling pensioner households to shop more price-consciously.

Figure 3. **Comparison of own-price elasticities for organic and conventional milk between different household groups in Germany**



* Price elasticities for organic milk for different income groups and different household sizes are not significantly different from zero. Therefore these graphs are printed tinged with pale grey.

For the conventional milk types own-price elasticity declines with rising income (cf. figure 3, column in the middle). For organic milk there are no significant differences between the income groups. Therefore the respective graph is printed pale gray. This result stresses again that once the decision for organic milk is made, income (and prices) do no longer play an important role.

In contrast to THIELE (2008), who finds a less elastic demand for milk in larger households, this study indicates that for CB milk price responsiveness increases with rising household size (cf. figure 3, column on the right). For CPL milk price elasticity is lower in single households

and in households with more than four persons than in households with two or three persons. For the organic milk types estimation results are again neither significant nor clear.

Regarding different retail formats, milk price sensitivity is higher in discount shops than in other retail outlets like supermarkets or large-scale retail (cf. table 5). The difference in price elasticities between different types of shops is especially high for OB milk. Demand in discount shops (-0.66) is considerably more elastic than in organic food shops (-0.22). This result is plausible as consumers in organic food shops are assumed to pay less attention to prices than consumers in discounters. For conventional milk, there are no great differences in consumer price responsiveness between different shop types. The demand for conventional milk in supermarkets reacts only slightly less to price changes than the demand in discounters.

Table 5. **Comparison of own-price elasticities for organic and conventional milk between different retail formats**

Own-price elasticities	Discounter	large Department store	small Department store	Supermarket	Organic food store
OB milk	-0.661 **	-0.341 **	0.032	0.022	-0.220 ***
OPL milk	-0.270 **	-0.166	-0.368 **	-0.034	---
CB milk	-0.723 ***	-0.658 ***	-0.628 ***	-0.540 ***	---
CPL milk	-0.561 ***	-0.483 ***	-0.368 ***	-0.405 ***	---

The different magnitude of own-price elasticity in several household groups and several retail formats underline that the use of average price elasticities for the population as a whole and for food retailing as a whole is problematic for the projection of future organic milk demand if there are significant changes in population or retail structure.

6 Conclusions and outlook

A growing number of studies deals with consumer decisions concerning organic food. However, only few provide quantitative estimates of price and income elasticities. This paper contributes to the existing literature by providing own-price elasticity estimates as well as analysis of the sociodemographic determinants of demand for organic milk. Following CRAGG's (1971) double hurdle model both the likelihood of market participation and the consumption levels are analyzed using actual homescan panel data. Thereby, consumer price sensitivity is estimated separately for different milk types, for different socioeconomic groups and for different places of purchase 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.

An important question to all market actors – especially after the economic crisis and the stagnation of the organic foods market in 2009 (BÖLW 2010) – is whether the organic milk mar-

ket in Germany will continue to grow or whether it will consolidate. The findings of this analysis suggest that the primary organic milk consumer is well educated, wealthy and without children living in the household. Thus, presumably, the share of organic milk consuming households will rise due to increasing educational attainment and income as well as due to decreasing number of children in Germany. Low income and price elasticities in the second step indicate that once the decision to buy organic milk is made, price and income do not play important roles. An inelastic demand implies that price campaigns at retail level are not the right instrument to increase sales and to facilitate growth. The combination of the first-step and the second-step results clearly show 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.

In consideration of the fact that consumers in Germany become increasingly interested in what they eat, the emphasis of benefits for health, environment and animal welfare may be an alternative marketing instrument that could be used to attract both extant and potential consumers. For example, aspects like the heightened content of omega-3 fatty acids in organic milk (see e.g., ELLIS et al. 2006), regional production, fair prices for dairy farmers as well as the lower incidence rate of 'organic cows' could be underlined. These aspects will probably get more important as the entrance of mass organic milk producers and retailers as well as the increasing globalization of the organic food market in Germany leads to an inherent tension between the principles of organic and sustainable farming and the imperatives of big business.

The results of the second-step censored regression also allow for drawing some methodological conclusions. A clear advantage of demand systems is the consideration of the restrictions of demand theory like adding-up, homogeneity and symmetry. Nevertheless, the comparison of results from different approaches can help to get a more detailed view on own-price elasticity estimates for organic products and to become aware of methodological specialties. JONAS and ROOSEN (2008) as well as GLASER and THOMPSON (2000) pointed out that the AIDS model tends to overestimate elasticities of commodities whose expenditure shares are rather small. The results of this study confirm this finding: While demand for organic milk in previous studies was found to be highly elastic, the present analysis suggests that the demand for organic milk in Germany is absolutely price-inelastic. Additionally, this paper shows that price responsiveness differs by milk type, household characteristics and retail format. Therefore, demand projections for organic milk based on elasticity estimates that do not account for changes in population and market structure seem to be error-prone.

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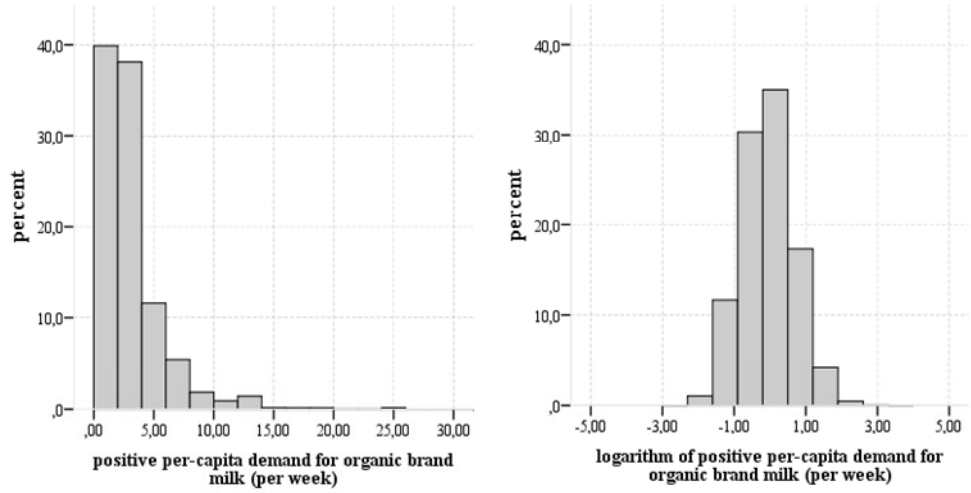
Appendix 1. **Distribution of per-capita demand for organic brand milk in original scale** (left hand side) **and in natural logarithm scale** (right hand side)



Appendix 2. **Results of the second-step estimation**

determinants	Variable name	Organic brand milk	Organic private-label milk	Conv. Brand milk	Conv. Private-label milk
Constant term	cons	**-0.327** (-1.51)	**-0.701** *** (-3.49)	**-0.516** *** (-9.45)	**-0.015** (-0.45)
Price of OB milk (real, logarithmiert)	p_OB	**-0.114** *** (-3.52)	**-0.069** (-0.94)	**0.253** *** (7.08)	**-0.045** (*) (-1.9)
Price of OPL milk (real, logarithmized)	p_OPL	**0.050** (0.67)	**-0.096** ** (-2.51)	**0.399** *** (12.68)	**0.082** *** (4.04)
Price of CB milk (real, logarithmized)	p_CB	**0.031** (0.12)	**0.063** (0.32)	**-0.624** *** (-94.26)	**0.641** *** (40.51)
Price of CPL milk (real, logarithmized)	p_CPL	**-0.090** (-0.46)	**-0.204** (-1.33)	**0.041** *** (3.34)	**-0.579** *** (-59.39)
Net income per-capita (real, logarithmized)	y	**0.010** (0.34)	**0.026** (0.99)	**0.028** *** (3.91)	**0.010** ** (2.12)
Trend	t	**0.00034** ** (2.27)	**0.00071** *** (4.85)	**0.00039** *** (12.76)	**-0.00016** *** (-7.04)
No. of children	kids18	**-0.051** (*) (-1.90)	**-0.058** ** (-2.53)	**-0.099** *** (-14.63)	**-0.091** *** (-22.7)
children < 7 years	D_{kids07}	**-0.025** (-0.71)	**-0.131** *** (-3.47)	**-0.127** *** (-12.21)	**-0.037** *** (-6.22)
Habit formation	lagged con-sumption	**0.012** *** (13.77)	**0.017** *** (20.05)	**0.011** *** (42.91)	**0.009** *** (79.38)
Seasonal dummies	D_{spring} (Mrz-May)	**0.066** *** (5.83)	**0.085** *** (8.37)	**0.051** *** (17.51)	**0.045** *** (23.9)
	D_{summer} (Jun-Aug)	**-0.035** *** (-3.35)	**-0.011** (-1.14)	**0.002** (0.73)	**0.054** *** (29.4)
	D_{winter} (Dez-Feb)	**0.031** ** (2.49)	**0.066** *** (5.88)	**0.031** *** (9.89)	**0.045** *** (21.45)
R^2 (within group)		**0.2529**	**0.2347**	**0.171**	**0.1661**
F-Test	F-value	**26.06** ***	**54.27** ***	**1,000.78** ***	**1,026.24** ***
No. of observations		18,794	24,453	267,609	804,705
No. of households		1,852	2,736	15,251	19,931
No. of observations per household	average	10.1	8.9	17.5	40.4
	maximum	175	149	189	194

Note. ***, **, * and (*) denote significance at 0.1, 1, 5 and 10 %, respectively. t-values in parentheses.