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Some neglected issues in food demand analysis: retail-level demand, health information and product quality†

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Food demand analysis is dominated by the econometric estimation of demand systems based on aggregate market data and steady progress has been made in analytical techniques. Yet some issues have been neglected in food demand analysis which are crucial for understanding recent consumption trends in industrialised countries. Three of these issues are dealt with here: analysis of food demand at the retail level; influence of health information on food demand; and importance of product quality for food demand. It is shown that answers to important questions in these areas can be given when large and unconventional data sets are used.

1. Introduction

Consumers' demands for foods in industrialised countries indicate major changes. Strong trends are the growing relative importance of away-from-home consumption, a rising internationalisation of food demand and a move in demand towards more specialised and diversified retail food outlets (Connor and Schiek 1997, chapter 9). Market shares of food retailers with a general low-price policy, e.g. discounters, are rising as are those of food retailers and food service chains, which offer sophisticated foods or meals in the high-price segment. This suggests that consumers might be very price-conscious in their average shopping behaviour and fastidious in their food demand for special occasions. Often, price consciousness and variety- and quality-seeking seem to be prevalent in a single consumer.

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Despite steady progress in analytical techniques, research in food demand analysis has not kept up with the richness of these structural changes in food demand. We would argue that the conceptualisation of mainstream demand analysis has contributed to the fact that some important issues have been widely ignored in food demand analysis. (i) Demand analyses, especially elasticity estimates, have been almost exclusively concentrated on aggregate market demand. (ii) Consumers' attitudes and expertises, in part also sociodemographic variables, have been included in surveys of marketing studies, but not systematically in economic studies of food demand. (iii) Product quality has been investigated within hedonic price analyses, but not systematically in the analysis of food demand functions.

It is the aim of this article to contribute to the explanation of recent consumption trends in industrialised countries, which have not been sufficiently addressed up to now. The analysis refers to prices as well as to important non-price influences on demand. The focus is on three issues which have been widely neglected in food demand analysis up to now: the analysis of food demand at the retail level; the influence of health information on food demand; and the importance of product quality for food demand. We will show that each of these issues can be dealt with in econometric analysis by use of non-traditional data sets.

With regard to the influence of prices and income on food demand, major progress has been made in recent decades in theoretical and quantitative demand analysis, especially in the theory and estimation techniques of demand systems (Deaton and Muellbauer 1980; Pollak and Wales 1991). A number of specifications of demand systems were estimated for many countries and a broad set of price and income elasticities of food demand as well as techniques for modelling structural change are available in the literature now. This important branch of the literature has been competently surveyed elsewhere (Blundell 1988; Moschini and Moro 1996). It is a stylised fact from estimated demand systems that the price elasticity of food demand and of major foods is absolutely low in industrialised countries. In order to evaluate whether this implies that consumers do not react strongly to price incentives, important lessons can be drawn from a more disaggregate analysis of retail demand. In section 2 we will provide some empirical evidence on price elasticities at the retail level and on how consumers respond to advertising and other marketing and promotion activities. Conclusions for food demand analysis will be drawn.

A further stylised fact from food demand analysis is that recent demand patterns in industrialised countries are driven more by changing attitudes, e.g. health concerns, than by the traditional variables of prices and income. Results from consumer surveys show the growing importance of health concerns and information on food demand (Caswell 1995), but due to data

limitations this has been incorporated in only a few econometric demand analyses. Empirical evidence with data from a German household survey will be provided in section 3. It will be elaborated how various indicators of health consciousness and knowledge about nutrition affect food demand and nutritional quality. Conclusions for the specification of demand models will be derived.

Although our supply of foods is plentiful and highly differentiated, the links between product quality and food demand are not yet fully understood. A broad and growing literature exists in which the implications of quality features for product prices are addressed within hedonic price models. However, the links between quality components and demand are often not covered in those analyses. Relevant questions are the following: Is demand for a heterogeneous product, e.g. wine, driven by objective quality as measured by the scientist? Or do subjective tastes with regard to design, image, etc., matter more? Is it more subjective taste or objective quality which explains price differentials? We will present some evidence on and a discussion of these issues in section 4. A summary of the findings follows in section 5.

2 Is food consumption in industrialised countries price-inelastic at a disaggregate level? A discussion of retail demand functions

There is ample evidence by now that the demand for food is price-inelastic in industrialised countries. Based on a complete system of US food demand, Huang (1993) shows that only two categories out of 39 foods or food groups are characterised by a price-elastic demand: other meats with a price-elasticity of -1.87 and grapes with a price elasticity of -1.18. All other estimates are in their absolute value below unity, and the values range in 28 cases between 0 and -0.5. If the individual foods are aggregated to only seven groups, all the estimated price elasticities are clearly below unity in the absolute values and range between -0.07 for fats and oils and -0.36 for meats and other animal products. These US findings are consistent with those for European countries.

Michalek and Keyzer (1992) estimate within a demand system for eleven foods or food groups in eight EC countries[1] price elasticities of demand for 1970 and 1985. Only seven out of 176 estimated own-price elasticities are above unity in their absolute values. All other uncompensated elasticities range between 0 and -1. Own-price elasticities of demand for total food in 1985 were clearly below unity in absolute terms. They ranged between -0.07

[1] Belgium and Luxembourg are treated as one country.

for Italy and -0.64 for Ireland, with Ireland being the only country with an estimate below -0.5.

From such findings and from empirical estimates of Engel functions, it is often concluded that demand becomes more price-inelastic with rising income level. Across households, Senauer, Asp and Kinsey (1993, p.146) justify this by stating that 'higher income households can afford to be less sensitive to price changes; poorer households are under more pressure to look for the best buys'. In a broader framework of consumer behaviour, it is often argued that changes in food demand become more and more associated with changes in preferences rather than with changes in income and prices (von Alvensleben 1997).[2]

Despite this evidence on price-inelastic food demand, it is well known that food retailers compete strongly by adopting very active pricing strategies. The latter observation might imply that food consumption in industrialised countries is price-inelastic at the aggregate level of market demand functions, but not necessarily at the point of sale. There is a rather recent literature on retail demand functions which addresses this issue. The studies are in most cases based on scanner data and, by now, the findings are much less comprehensive than those of the traditional food demand literature. After a brief review of the existing evidence on retail demand, we will present some recent German results on this issue and draw some economic conclusions.

Various retail demand analyses for the United States refer to sales of meat and meat products. Capps (1989) considers data from a food retail firm in Houston and point-of-sale purchases of meat products from January 1986 to June 1987. Price elasticities of demand for the individual meat products are in most cases statistically different from zero and negative as expected. The statistically significant own-price elasticities are remarkably low for retail-level data and generally inelastic except for the roast beef demand with a coefficient of -1.27. There are positive and statistically significant own-advertisement elasticities of demand. Their magnitude is very low, however, with values below 0.05 in all cases. As in the Capps study, Brooker, Eastwood and Gray (1994) measure responses of beef demand to prices and advertising. The analysis is based on weekly data for May 1988 to June 1991 in two foodstores in the Southern United States. Apart from season-related dummy variables, a significant negative influence of prices and a positive impact of advertising on demand is shown by the authors. In contrast to the Capps results, the own-price elasticities of demand are in the elastic range

[2] This statement touches upon the important issue of whether preferences change or remain stable. For this discussion, see the seminal paper by Stigler and Becker (1977) and, for a different view, Cowen (1989).

for all three meat products, whereas advertising elasticities are again below unity in absolute terms.

Earlier studies also confirm the hypothesis of a price-elastic demand for beef at the store level. Funk, Meilke and Huff (1977) estimated own-price elasticities for beef demand in Toronto markets which are well above unity in absolute terms. Moreover, they also found inelastic own-advertising elasticities. Marion and Walker (1978) analysed the sales of five meat products in two Ontario supermarkets with 32 weekly observations. With regard to price elasticities, Marion and Walker showed that 80 per cent of all estimates are in the elastic range. Individual beef products like beef loin reach values between -3.0 and -7.2. Price elasticities differ somewhat across stores and weeks. It is elaborated in the analysis that the proximity to paydays, weeks within the month, season and temperature affect weekly meat demand.

A much broader analysis in terms of analysed products is provided by Hoch *et al.* (1995). These authors analyse weekly scanner data for eighteen product categories, including twelve categories of foods and beverages, of a major chain in the Chicago metropolitan area. Data for 160 weeks were available and price elasticities were computed with information from 80 weeks and 83 stores. The results of Hoch *et al.* support the view that the own-price elasticities of demand for promoted products are above unity in absolute terms for most categories of food and beverages. The average category elasticity, which can be expected to range lower, is still above unity in five out of twelve food and beverage categories. An additional interesting result by Hoch *et al.* is that demographic and competitor variables explain a large share of the variation in price response. Demographic variables are found to be more influential than competitor variables.

It can be concluded that there is some evidence on price-elastic consumer behaviour at the retail level, but the results are not uniform. Recent econometric results for Germany show an important additional aspect. The price elasticity of demand at the retail level is strongly affected by the way stores inform customers of special prices, i.e. how other marketing-mix variables support the stores' price policies. This issue has been widely ignored in the American scanner data literature up to now. Schäfer (1997) analyses weekly scanner data for five stores of a food chain over a one-year period, May 1994 to April 1995. He focuses on wine demand for promoted wines and all wines. Schäfer reports price elasticities of retail-level demand for wine where price reductions were combined with various promotion activities. Some major results are summarised in table 1. Promotion refers to in-store display of the product (variables W, X and Y) and leaflet distribution (variable Z). In-store display in the foodstore may be at spots with or without high customer frequency (variable W). The duration of the in-store

Table 1 Regression coefficients on the sales effects of price reductions for wine in the context of selected marketing and promotion strategies (five German foodstores)[a]

Marketing and promotion strategies[b]	Price elasticity of retail demand		Number of observations
	correction for seasonality	no correction for seasonality	
Base case: Price change without additional promotion	− 0.20**	− 0.25**	—
Type 1: *W*2, *X*1, *Y*2, *Z*2	− 1.69*	− 1.21	608
Type 2: *W*1, *X*2, *Y*1, *Z*2	− 1.69*	− 1.52*	513
Type 3: *W*1, *X*1, *Y*2, *Z*2	− 2.59*	− 4.80**	215
Type 4: *W*3, *X*3, *Y*3, *Z*1	− 3.88**	− 4.78**	1280
Type 5: *W*1, *X*1, *Y*2, *Z*2	− 4.53**	− 5.12**	1180
Type 6: *W*1, *X*1, *Y*1, *Z*2	− 5.02**	− 4.42**	813
Type 7: *W*2, *X*2, *Y*2, *Z*2	− 5.82**	− 6.11**	410
Type 8: Any in-store display, *Z*1	− 8.29**	− 9.48**	300

Notes:
** Statistically significant at the 99 per cent level, * Statistically significant at the 95 per cent level.
[a] The numbers indicate price elasticities of retail demand as explained in the text.
[b] The symbols can be explained as follows: *W*, *X* and *Y* refer to in-store display strategies and variable *Z* to the fact whether leaflet distribution occurred or not. *W*1(*W*2) indicates in-store display at a spot in the store with high (low) customer frequency. *X*1(*X*2) refers to a special placement that is kept up to eight (more than eight) weeks. *Y*1(*Y*2) indicates that advertised wines are presented in a size below 0.25 Euro palettes (0.25 Euro palettes or higher). *Z*1 indicates that leaflet distribution occurred, whereas *Z*2 characterises the situation without leaflet distribution. The combination *W*3, *X*3 and *Y*3 stands for the situation without in-store display.
Source: Adapted from Schäfer (1997), various tables.

display is distinguished in up to eight weeks or more (variable X), and the size of the additional wine display is also measured (variable Y).

Methodologically, the combinations of promotional activities have been introduced by Schäfer in various forms in the regression analysis. The price policies and non-price promotion activities have been considered first as separate regressors in a model:

$$\hat{q} = \alpha_o + \alpha_1 D_1 + \ldots + \alpha_n D_n + \beta_o \hat{p}. \quad (1)$$

Additionally, the combinations of price policy with non-price promotion activities have been captured in multiplicative form, i.e. with slope dummies:

$$\hat{q} = \alpha_o + \alpha_1 D_1 + \ldots + \alpha_n D_n + \beta_o \hat{p} + \beta_1 \hat{p} D_1 + \ldots + \beta_2 \hat{p} D_n. \quad (2)$$

Thus $\hat{q}$ is the percentage change in sales, defined relative to mean weekly sales; $\hat{p}$ is the percentage price change. D_1 to D_n are dummy variables which stand for certain types of promotion activities as specified in table 1 and β_o refers to the price elasticity of demand in the pure case of a price change without other promotion activities.

In one set of regressions, the percentage change in sales is also corrected for seasonal influences on sales. Table 1 shows the price elasticities from equation 2. By use of the multiplicative demand specification, conclusions can be drawn on how non-price promotion supports the sales impact of a price reduction.

Table 1 shows that price elasticities of retail demand are crucially affected by the way price changes are communicated inside and outside the store. The basic price elasticity of retail demand for wine is -0.20, if the price policy is not supported by sales promotion. The demand reaction increases substantially when other promotion activities are added. The other marketing-mix combinations shown in table 1 reveal price-elastic sales impacts. When wines are presented on in-store displays, e.g., at spots with a high customer frequency, a duration of the special placement up to eight weeks on small palettes and no leaflet distribution occurs, the price elasticity of demand becomes -5.0. Leaflet distribution further increases the price elasticity of demand. We see how price-responsive consumers behave when buying an advertised wine. Further important results of the analysis are the following:

1. There are synergy effects between special in-store displays and leaflet distribution. If a 1 per cent price change is combined with both promotion activities, the percentage change in demand is higher than the sum of the percentage changes due to equivalent price changes associated with a separate application of the two promotional activities.
2. There is a certain substitution between the sales of promoted wines and all other wines. Separate regression results in Schäfer (1997, table 24) show that an increase of demand for promoted wines by one litre is associated with a reduction of the demand for other wines by 0.67 litres. This implies that a relatively significant sales effect of promotion remains for the aggregate product category.[3]

We can summarise that these results cast considerable doubt on generalisations of the hypothesis of price-inelastic demand for foods. At a disaggregate level of retail demand, consumers seem to react strongly to

[3] The consequential question, how earnings in the product category wine were affected by promotion activities, was not analysed in the study by Schäfer (1997). We know from the theory of pricing in multiproduct firms, however, that the earnings effect of a price reduction is determined by the price elasticity of demand of the promoted good, the cross-price elasticity between non-promoted products and the promoted good as well as earning shares of promoted and non-promoted goods.

changes in price.[4] This holds true particularly if price specials are combined with additional promotion activities. This finding is certainly consistent with the observation that price policy is a major marketing activity in the retailing sector of industrialised countries. It is also consistent with the fact that discounters increase their market shares in food distribution in many industrialised countries, since price-conscious consumers will appreciate the existence of stores with a general low-price policy.

Strong demand reactions to specials in industrialised countries seem to be inconsistent with the view that prices decline in importance with rising income. Certainly, poorer consumers are forced to look for the best buys. There are other factors, however, which may work towards a strong price reaction even in high-income households and in high-income economies. Household infrastructure improves with income, and a better infrastructure enables high-income households to buy at lower average costs. The availability of refrigerators or a second car in the family are cases in point. This infrastructure may lead either to higher storage if prices are particularly low or it implies easier shopping at low-price stores out of town.

Analyses of food demand at the points of sale with scanner data have several advantages.[5] It is obvious that marketing implications can be derived immediately from these analyses. Beyond that, however, a more detailed knowledge of price elasticities of demand at the points of sale is essential for an analysis of trends in market structure at the retail level. It is also crucial for an explanation of a changed market position of certain types of foodstores, i.e. low-price stores, as opposed to the food industry. A strong price-responsive retail-level demand will also be a certain barrier against market power and might well have important implications for antitrust policy.

3. Are health concerns and nutrition information important determinants of food demand? A discussion of empirical results from a German household survey

Food demand patterns and dietary habits in industrialised countries are changing. In the case of Germany we can observe a trend towards consumers who are well informed about health and nutrition and who are concerned about food quality and food safety (Brockmeier 1993; Wiegand and von

[4] It could be argued that consumers' purchases of wine are different from purchases of many other foods. In Canada and the United States, wine cannot be bought in grocery stores in all parts, and the sales through liquor stores are important. This argument is not valid for Germany, however. The major share of wine is sold in grocery stores and the price elasticity and the income elasticity of wine demand are below unity in absolute terms as for many other foods (Pinkau 1994).

[5] For a discussion of the advantages and weaknesses of scanner data as a non-traditional data source, see Buse (1992).

Braun 1994; von Alvensleben 1995). At the same time we are confronted with a high incidence of diet-related diseases that contribute to early death as well as to substantial costs for the health sector. In Germany, the rate of deaths that can be linked to diet-related diseases, amounts to about 30 per cent (Kohlmeier *et al.* 1993).

A comprehensive national food consumption survey is used in order to demonstrate how the inclusion of nutrition information variables contributes to a better understanding of food demand patterns and dietary quality. Compared to other studies, which either include nutrition information variables in the form of an index derived from publications (Brown and Schrader 1990; Chern, Loehman and Yen 1995; Kinnucan *et al.* 1997) or investigate the influence of health or nutrition information variables only for single foods or nutrients (Jensen and Kesavan 1993; Jensen 1995; Variyam, Blaylock and Smallwood 1996), it is possible with this data set to investigate the influence of the mentioned variables on the demand for up to 90 food groups as well as dietary quality and nutrient consumption, respectively. This allows comparisons of the impact and the magnitude of attitude and knowledge as well as sociodemographic and other independent variables between food groups. Overall dietary quality as opposed to intake of single nutrients is investigated in the case of nutrient intake.

Some fifteen food demand equations are estimated for a representative cross-sectional sample of 9 672 Germans who are at least fourteen years or older. The studied population are randomly chosen household members who, in addition to a seven-day food protocol, had to complete a comprehensive questionnaire regarding eating and health behaviour, attitudes and knowledge.[6] Independent variables which enter the analysis are — apart from household income and the presence of a freezer — household characteristics like household size, age, sex, educational attainment[7] and hours worked. Regional as well as seasonal variables are included. Five variables measure a person's attitude towards healthy nutrition: the degree to which an individual pays attention to several recommendations regarding a healthy nutrition;[8] the number of meals eaten per day;[9] interest in nutrition issues; the number of foods considered to be important for a healthy diet; and the shopping

[6] Sample characteristics and definition of variables can be obtained upon request.

[7] Educational attainment is subdivided into four categories, SCHOOL4 being the highest level of education, i.e. an academic degree.

[8] These include, for example: 'not too much fat', 'lots of vitamins', 'moderate use of salt', 'little cholesterol', 'lots of fresh fruit and vegetables', etc.

[9] From the nutritionist point of view it is positive to eat more meals a day provided that each meal is relatively small.

Table 2 Measures of dietary quality

	Mean	Standard deviation
Variety 90 → No. of food groups from which foods were consumed (max. 90)	45.7	7.5
Underconsumption → No. of nutrients with consumption below 2/3 of recommended levels (max. 25)	6.3	5.0
Overconsumption → No. of nutrients with consumption above recommended levels (max. 7)	5.4	1.0
Fat-Calories → fat intake as percentage of total energy intake	42	6

Source: Own computations with data from the 'Nationale Verzehrsstudie'.

frequency for food per week. Another three variables measure an individual's knowledge of nutrition issues: awareness of the beneficial effects of dietary fibre; knowledge of the calorie content of various foods; and knowledge of diseases which might result from unhealthy diets. Finally, three variables that describe an individual's health condition are included: the Body-Mass-Index; being on a diet; and suffering from a diet-related disease.

Food consumption data were aggregated into 24 broad food groups. Out of the 24 groups, food demand equations for only fifteen food groups are presented here (see table 3). Furthermore, individual food consumption data were transformed into nutrient intake. By considering the intake of various nutrients it is possible to establish objective measures of dietary quality (see table 2) (Roeder 1997). The influence of nutrition and health information variables as well as other independent variables on dietary quality is investigated again.

Major results for the food demand equations are as follows:

1. Out of the fifteen food groups investigated, income was a significant determinant of food demand in only eight cases. With the exception of meat and alcoholic beverages, the size of the income elasticity was very small and did not exceed 0.06.
2. The per-capita demand for the food groups under investigation decreases with a rising household size. Exceptions are bread and bakery products and potatoes. These products are relatively inexpensive and often considered to be inferior.
3. A generally positive relationship can be identified between age and food consumption. Older persons tend to consume more of all investigated foods except for milk and dairy products, meat, candy and sweets/confectionery[10] as well as cereal products.

[10] This category, defined by us, contains chocolate and chocolate products, candy, gum, ice cream and honey.

4. There are significant gender differences in food consumption. In general, women eat less than men. This result might basically reflect the fact that their physiological energy needs are lower. There are exceptional food groups, however, for example, women's consumption of fresh and tropical fruit exceeds the men's consumption.
5. Education variables are important determinants of food consumption. Educational attainment appears to be significant in general, with bread and bakery products as well as fish and fish products being the exceptions.
6. Regional as well as seasonal effects of consumption patterns can be identified for the majority of foods.
7. Attitude variables significantly influence food consumption. The magnitude of the coefficients is relatively small, however.
8. Knowledge of nutrition issues is also a significant determinant of food consumption but again the coefficients are rather small.
9. There are significant relationships between the health condition and food consumption. A relatively high Body-Mass-Index is related to an increased consumption of protein-rich foods, for example. Being on a diet also results in modified eating patterns.
10. Variables which have the strongest impact, i.e. the highest coefficients, on food demand are the education variables, followed by age, regional variables, sex, health condition and seasonal variables. This finding indicates that income is not a crucial determinant of food consumption in Germany.
11. Even though attitude and knowledge variables are significant determinants of eating behaviour in most of the food regressions, the absolute size of the coefficients is fairly small. Nevertheless, the exclusion of these variables leads to a notable decrease in the coefficients of determination.

Table 3 shows the results discussed above in more detail for the various foods. The equations were estimated using OLS and a double-logarithmic specification in order to directly obtain elasticities and to allow a comparison of coefficients between equations.[11] The following section will primarily discuss the strongest determinants of food consumption.

[11] Heteroscedasticity, a problem that frequently occurs in large cross-sectional data sets, was corrected by estimating the demand equations using the White-estimator (Greene 1997). The demand equations were also estimated employing different functional specifications, i.e. allowing for declining income elasticities. However, the obtained estimates were not substantially different from the results presented here. With the double-logarithmic specification it is possible to compare the magnitude of the effects of the continuous exogenous variables, e.g. income and age, on food demand.

Table 3 The impacts of variables related to eating behaviour on the consumption of food groups in Germany

	Fresh vegetables	Bread + bakery prod.	Fish + fish products	Fresh fruit	Milk + dairy products	Cheese	Meat	Proc. meat + sausages
Constant	2.934***	4.814***	0.660	0.857	5.748***	2.032***	2.781***	1.991***
INCOME	0.047**	−0.034**	0.044	−0.001	−0.058*	−0.009	0.109***	0.058**
FREEZER	0.065***	0.000	0.103**	0.000	−0.028	−0.082**	0.122***	0.064**
Household characteristics								
HOUSEHOLD SIZE	−0.047*	0.024*	−0.126**	−0.125***	−0.140***	−0.110***	0.036	0.009
AGE	0.198***	0.135***	0.298***	0.424***	−0.281***	0.240***	−0.060*	−0.009
SEX (Female = 1)	−0.040*	−0.261***	−0.200***	0.236***	0.012	−0.078**	−0.248***	−0.436***
SCHOOL2 (10 years)	0.041*	0.008	−0.021	0.154***	0.188***	0.094***	−0.115***	−0.108***
SCHOOL3 (13 years)	0.110***	0.010	−0.030	0.282***	0.274***	0.248***	−0.246***	−0.291***
SCHOOL4 (academic)	0.215***	0.007	0.022	0.289***	0.393***	0.369***	−0.223***	−0.294***
HOURS WORKED	−0.005	−0.001	−0.002	−0.007	−0.012**	0.005	0.004	0.009***
Region								
CITY	0.011	−0.051***	0.024	0.013	−0.057*	0.039	−0.042*	−0.045*
CENTRAL	0.025	0.070***	−0.071	−0.127**	−0.181***	0.038	0.016	0.177***
NORTH	−0.054*	0.005	0.033	−0.087*	0.044	−0.014	−0.055*	−0.066**
SOUTH	0.103***	0.030	−0.018	−0.030	−0.116**	−0.114**	−0.066**	0.234***
Season								
QUARTER 2	0.134***	0.034*	−0.077	0.203***	0.031	0.027	0.043*	0.068**
QUARTER 3	0.191***	0.011	−0.162***	0.568***	−0.016	0.011	0.014	0.023
QUARTER 4	0.073***	0.043**	−0.105*	0.245***	−0.087*	−0.008	0.009	0.032
Attitudes								
FOLLOW RECOMM.	0.018***	−0.007***	0.005	0.036***	0.018***	0.011**	−0.009***	−0.018***
No. of MEALS/DAY	0.032***	0.096***	−0.013	0.095***	0.156***	0.056***	0.027***	0.050***
INTEREST in NUTR.	0.059***	0.008	0.011	0.101***	0.066***	0.063***	−0.050***	−0.051***
No. of FOODS IMPORT	0.001	0.006**	0.003	−0.011	0.001	−0.004	0.016***	0.020***
SHOPPING	0.007	−0.007*	0.006	−0.004	−0.004	−0.003	0.013**	0.003
Knowledge								
FIBRE KNOWLEDGE	0.067***	0.010	−0.004	0.095***	0.058**	0.085***	−0.029*	−0.034*
CALORIE CONTENT	0.003	−0.009**	0.008	0.007	−0.005	0.016*	−0.002	−0.006
DISEASE KNOWL.	0.013	−0.001	−0.005	0.003	0.006	0.006	−0.006	−0.007
Health condition								
BMI	−0.086	−0.014	0.327*	−0.010	−0.184	−0.003	0.279***	0.536***
DIET	−0.004	−0.238***	−0.054	0.203***	−0.022	0.106*	−0.013	−0.208***
DIET-REL. DISEASE	0.009	−0.021	0.023	0.000	−0.018	0.009	0.022	−0.012
$\bar{R}^2$	0.070	0.126	0.029	0.094	0.061	0.048	0.090	0.167
F-Value	28.001***	52.805***	6.886***	32.501***	23.960***	18.166***	35.634***	71.380***

	Butter	Alcoholic beverages	Candy + sweets/ confectionery	Tropical fruit	Cereal products	Potatoes	Coffee
Constant	1.778***	3.211***	4.752***	2.152***	5.457***	3.702***	3.546***
INCOME	0.053	0.256***	−0.022	−0.068	−0.047*	−0.014	0.062**
FREEZER	0.013	0.012	0.031	0.051	−0.010	0.021	0.016
Household characteristics							
HOUSEHOLD SIZE	−0.080*	−0.171**	−0.079*	−0.194***	0.006	0.057**	0.032
AGE	0.427***	0.228**	−0.350***	0.151	−0.452***	0.247***	0.245***
SEX (Female = 1)	−0.129***	−1.128***	−0.054	0.251***	−0.179***	−0.245***	0.043
SCHOOL2 (10 years)	0.075*	0.086	0.219***	0.180**	0.058*	−0.073***	−0.040
SCHOOL3 (13 years)	0.141**	0.079	0.260***	0.386***	0.054	−0.135***	−0.151***
SCHOOL4 (academic)	0.173***	0.300***	0.369***	0.317***	0.228***	−0.183***	−0.096**
HOURS WORKED	−0.003	0.028***	0.001	0.005	−0.006*	−0.012***	0.009**
Region							
CITY	−0.007	0.066	0.034	0.090	0.035	−0.084***	−0.003
CENTRAL	0.132**	0.316***	−0.036	−0.011	0.205***	−0.109***	−0.146***
NORTH	0.202***	−0.078	−0.034	0.015	−0.068*	−0.011	−0.099***
SOUTH	0.173***	0.488***	−0.066	0.019	0.391***	−0.414***	−0.338***
Season							
QUARTER 2	0.064	0.080	0.176***	−0.486***	−0.040	0.031	0.040
QUARTER 3	0.017	0.171**	0.065	−0.686***	−0.033	0.007	0.030
QUARTER 4	−0.026	0.025	−0.040	−0.276***	0.002	0.020	−0.015
Attitudes							
FOLLOW RECOMM.	−0.025***	−0.022**	−0.019***	0.039***	−0.008*	−0.006*	−0.010**
No. of MEALS/DAY	0.037*	−0.100***	0.084***	0.130***	0.062***	0.029**	0.106***
INTEREST in NUTR.	−0.023	−0.085***	0.030	0.112***	0.037***	−0.007	−0.002
No. of FOODS IMPORT	0.043***	−0.004	0.006	−0.010	0.013***	0.016**	−0.002
SHOPPING	0.014	0.049***	0.012	0.028	0.009	−0.001	0.020**
Knowledge							
FIBRE KNOWLEDGE	0.003	0.020	0.037	0.044	0.042**	−0.036**	0.063***
CALORIE CONTENT	−0.010	0.037**	0.005	0.015	−0.010	−0.012*	0.019**
DISEASE KNOWL.	−0.007	−0.009	0.039***	0.029	0.023**	−0.005	−0.006
Health condition							
BMI	−0.511***	−0.065	−0.378***	−0.059	−0.233**	0.048	0.133
DIET	−0.544***	−0.388***	−0.105	0.285***	−0.151***	−0.222**	−0.125**
DIET-REL. DISEASE	−0.080**	−0.133**	−0.011	−0.050	−0.042	−0.015	0.005
$\bar{R}^2$	0.053	0.132	0.068	0.060	0.105	0.108	0.042
F-Value	20.248***	46.250***	21.202***	16.664***	42.901***	43.488***	15.600***

Notes: *** (**, *) statistically significant at the 99.9 per cent (99 per cent, 95 per cent) level, respectively.
Source: Own computation with data from the 'Nationale Verzehrsstudie'.

Seasonal variables reveal the highest coefficients in determining consumption of fresh and tropical fruit as well as fresh vegetables. In addition, educational attainment, age and household size are important determinants regarding the size of the coefficients. Holding an academic degree, for example, increases the consumption of fresh and tropical fruit by 30 per cent per day and consumption of fresh vegetables by 22 per cent compared to the consumption of a reference person.

Consumption of milk and dairy products and cheese is mainly positively related to education and age. The consumption of both food groups increases per person with educational attainment. With older age, however, the cheese consumption still increases whereas the consumption of milk and dairy products declines. There are also regional variables which positively influence the consumption of the two food groups. The most influential determinant of butter consumption is being on a diet. Dieting as well as a high Body-Mass-Index lead to a major reduction in butter intake. Age, another important variable, is positively related to a higher butter consumption on the contrary.

The Body-Mass-Index (BMI) variable also reveals the highest coefficients for consumption of meat, processed meat and fish. A higher consumption of the food group can be found in all three cases, the higher the BMI. Consumption of these food groups differs also between gender with women consuming smaller amounts of meat (25 per cent less), processed meat (44 per cent less) and fish (20 per cent less). In the case of meat and processed meat, again the education variables play an important role. Intake of meat and meat products decreases the higher the educational attainment.

If bread consumption is considered, women consume 26 per cent less bread than men. Approximately the same effect has being on a diet. It reduces the bread consumption by about 24 per cent. On the other hand, bread consumption increases with age and the number of meals eaten per day. Consumption of cereal products (pasta, rice, etc.), however, declines with increasing age as well as with a higher BMI. Holding an academic degree, on the other hand, relates to a 23 per cent higher cereal consumption.

In comparison to the west, potato consumption is 41 per cent higher in the southern part of Germany. Moreover, it increases with age. Women and people on a diet eat substantially fewer potatoes, 25 per cent and 22 per cent, respectively. A strong negative effect on potato consumption is also found for the education variables. Living in the South and an increasing age have the strongest positive impact on the consumption of coffee.

The gender variable has the strongest influence on alcohol consumption. Consumption of alcoholic beverages is also significantly reduced if people follow a diet, i.e. by 40 per cent. Substantial positive effects exist for residing in southern and central parts of Germany as well as holding an academic

degree. Finally, the higher the BMI, the fewer candy and sweets are consumed. Candy consumption increases, however, with educational attainment but decreases with age.

If the most influential variables are evaluated by the size of their coefficients, it appears that attitude and knowledge variables are not among them. The Body-Mass-Index and the diet variable which both describe a person's health and body condition are the only exceptions. Nevertheless, attitude and knowledge variables are highly significant in many cases, indicating that they should not be ignored in demand specifications. The measurement of such variables might need improvement, however.

Major results for the dietary quality equations (see table 4) are as follows:

1. Income has a significant but very small influence on three of the four investigated measures of dietary quality. Food variety increases with increasing income as well as overconsumption of nutrients while underconsumption drops.
2. To some extent, an increasing household size leads to a reduced dietary quality for an individual. Food variety and the chance of underconsumption diminish with higher age. The relative fat intake increases at the same time.
3. Gender differences affect dietary quality, especially underconsumption of nutrients. Being female increases the number of nutrients which are not consumed in sufficient amounts by 34 per cent.
4. The education variables have a very significant and strong positive effect on dietary quality. Food diversity becomes larger with educational attainment whereas underconsumption of nutrients and calorie intake from fat decline.
5. Dietary quality differs somewhat by region. Persons in the South tend to have more variety in their diet, but are also more exposed to over- and underconsumption.
6. Attitude variables influence dietary quality significantly. With the exception of the variable that measures the number of meals per day, the coefficients are rather small, however. Significant but small coefficients can also be found for the knowledge variables.
7. The diet variable is responsible for the only significant influence arising from health condition. Being on a diet tends to reduce the quality of the overall eating behaviour.

Similar to the demand equations for food groups, the educational attainment is among the variables which have the strongest influence on all measures of dietary quality except for overconsumption of nutrients.

Table 4 The impacts of variables related to eating behaviour on dietary quality

	Variety (90 food groups)	Over-consumption	Under-consumption	Fat-calories
Constant	3.498***	1.459***	3.113***	4.772***
INCOME	0.023***	0.012*	−0.039*	−0.003
FREEZER	0.010*	0.013*	0.001	0.012**
Household characteristics				
HOUSEHOLD SIZE	−0.003	−0.015**	0.108***	0.012**
AGE	−0.016**	−0.006	−0.125***	0.022***
SEX (Female = 1)	0.004	−0.060***	0.339***	0.032***
SCHOOL2 (10 years)	0.028***	0.000	−0.068***	−0.020***
SCHOOL3 (13 years)	0.039***	−0.001	−0.125***	−0.028***
SCHOOL4 (academic)	0.066***	0.026**	−0.217***	−0.031***
HOURS WORKED	0.000	−0.001	0.003	0.000
Region				
CITY	0.006	−0.003	0.002	−0.016***
CENTRAL	0.014*	0.028***	0.040	−0.022***
NORTH	0.002	0.008	0.018	0.000
SOUTH	0.023***	0.026***	0.057*	−0.049***
Attitudes				
FOLLOW RECOMMEND.	2.46E-05	−0.003***	−0.004	−0.001*
No. of MEALS/DAY	0.031***	0.027***	−0.135***	0.010***
INTEREST in NUTRITION	0.007***	−0.004	−0.042***	−0.005**
No. of FOODS IMPORTANT	0.004***	0.006***	−0.011**	0.003***
SHOPPING	0.000	0.002	−0.007	−0.001
Knowledge				
FIBRE KNOWLEDGE	0.016***	0.006	−0.050***	−0.009**
CALORIE CONTENT	0.006***	0.001	0.006	0.000
DISEASE KNOWLEDGE	0.004**	0.003	−0.020*	−0.003
Health condition				
BMI	−0.019	0.004	−0.048	0.003
DIET	−0.059***	−0.127***	0.128***	−0.050***
DIET-RELATED DISEASE	0.003	−0.004	0.009	0.002
$\bar{R}^2$	0.085	0.068	0.084	0.058
F-Value	39.335***	31.273***	37.429***	26.133***

Source: See table 3. The same levels of statistical significance hold again.

Food variety as well as nutrient overconsumption and underconsumption are strongly influenced by the variable that measures the number of meals people eat per day. The more meals are eaten, the fewer the nutrients are consumed in insufficient amounts and the larger the variety of foods eaten. At the same time, a tendency towards overconsumption of nutrients that are considered risk factors for the development of diet-related diseases can be observed.

In summary, it can be said that the income coefficients are relatively small in comparison to other determinants of food demand or dietary quality. However, household characteristics variables can explain a fair share of the

eating behaviour. Variables of this kind can be recorded at relatively low cost and at the same time appear to be important determinants of dietary habits.

Although knowledge and attitude variables are frequently significant determinants, they have a rather limited influence in comparison to the household characteristics. When comparing a model including attitude and knowledge variables to a specification without these variables, the overall explanatory power clearly supports the specification with attitude and knowledge variables.

It is most likely that additional aspects influence nutrition-related attitudes and knowledge which could not be incorporated in this analysis. It is easy to imagine that a person does not separately evaluate his eating behaviour but considers it as a part of life in general. Therefore, the choice of the food might also be influenced by sporting activities as well as other lifestyle conditions. The measurement of these factors lies outwith the scope of this study. It is also conceivable that substitutional effects between food groups exist and they might be influenced by nutrition information variables. An individual might, for example, knowingly eat more candy and sweets and, in order to compensate for this rather unhealthy eating behaviour, reduce butter consumption accordingly.

The major conclusions to be drawn from this analysis are the following. With a large and representative data set like the German National Food Consumption Study it is possible to include variables in demand analysis variables which are often subsumed in the preference structure. Preferences are generally assumed to be constant and are then expressed via the choice of the functional form. In this study an attempt was made to disaggregate preferences by translating them into variables that describe attitudes and knowledge. By so doing it could be shown that there is a considerable number of significant non-income determinants of food consumption. In addition to the health and diet information variables, a significant influence could correspond to household characteristics, income, region, season and health condition.[12]

From the various groups of exogenous variables it could be shown that education dominates food consumption behaviour in this cross-sectional analysis. General education appears to be more important than nutrition-

[12] The reason for choosing single equations over a demand system specification was the flexibility with regard to the functional form when including health or nutrition information variables. The selected specification also allows a comparison of the results from the food demand equations with the results obtained from the dietary quality equations. Moreover, neither price nor expenditure data were collected in the food consumption survey considered, which impedes a demand system estimation.

specific knowledge. A positive relationship between the two determinants is very likely to exist but the effect might also be caused by the way of measuring the variables. Whereas general education is measured in years of education, nutrition knowledge is measured with regard to several nutritional aspects and therefore at a more elaborate level.

In conclusion, the analysis of household consumption data on a cross-sectional basis is an important instrument in improving the structure of demand models. However, cross-sectional models might not be sufficient to explain demand behaviour completely, as they do not take dynamic aspects into consideration. In this context the formation of habits is assumed to play an important role in determining eating behaviour.

Finally, it is certainly a challenge to include prices in analyses like the present study. Even in cross-sectional surveys, prices are likely to vary between households because households are exposed to different infra-structures and opportunity costs.

4. Is demand for non-homogeneous commodities driven by objective or subjective quality? A discussion of links between quality, prices and demand

Quality issues are becoming more important in the agricultural and food sector. Many foods are typically non-homogeneous, and quality uncertainty is playing an increasing role, particularly in the context of a growing concern about food safety (Caswell 1995). Therefore, it is a major challenge to investigate the influence of product quality on prices and demand. In the last decades, the economics of product characteristics has developed strongly and has provided a theoretical foundation for hedonic market analyses (Ladd 1982; Lancaster 1971, 1979). The influence of product characteristics on prices has been measured empirically in hedonic price models and, in many cases, the implicit valuation of product characteristics by consumers has been derived from those models. It is, however, problematic to regard implicit prices as an indicator only of consumers' valuation without considering the supply side. As far as product characteristics affect marginal utility as well as marginal costs, implicit prices derived from hedonic models characterise an equilibrium between supply and demand in the product market or the market for a product characteristic (Rosen 1974). For an econometric analysis, this implies that the influence of product characteristics on demand has to be derived within a simultaneous market model.

We will survey briefly how product quality has been incorporated in hedonic price and demand models for the food sector. New evidence will then be presented from ongoing research on the German wine market. In the literature review, it will be stressed that earlier studies have

incorporated objective as well as subjective quality elements. Objective food quality is what scientists typically define as product quality. In the case of wine, which will be analysed, we would define objective quality as the sum of all sensory characteristics of a wine.[13] Subjective food quality, on the other hand, is defined as the individual consumer's view of product quality. It may depend on objective quality characteristics directly but can also depend on quality signals which may or may not correlate with objective quality. This distinction between subjective and objective quality is crucial in the following analysis. It will be discussed whether it is the more subjective or the objective quality which explains price differentials. We will also investigate whether demand for heterogeneous products is driven by objective quality as measured by scientists or rather by subjective tastes or views with regard to design, image, etc. Whereas most studies concentrated on the estimation of reduced-form models,[14] i.e. hedonic price models, the evidence presented from ongoing research on the German wine market will also incorporate the quality-demand link within the framework of a simultaneous market model.

Table 5 gives an overview of selected empirical studies of product characteristics in the agricultural and food sector. It can be seen that hedonic price models dominate in the literature in comparison to complete demand and supply models. The influence of measurable objective product characteristics on prices is investigated in those models. The impact of nutrient components on food prices or of baking quality characteristics on wheat prices are cases in point. The evidence in the literature reveals that product characteristics matter in many cases for the explanation of product prices in many cases. Although most studies have primarily focused on objective quality, there is also some evidence that consumers utilise other quality signals in their judgement of product quality. There is evidence, e.g. that the name of firms or brands matters for the price charged on markets (Morgan, Metzen and Johnson 1979; Brockmeier 1993). Similarly, the wheat market analyses indicate that the country of origin may be a quality signal apart from objective product quality attributes (Veeman 1987; Larue 1991).

Additional conclusions on the relative importance of subjective versus objective quality can be drawn from ongoing research work by Seidemann (1998) with regard to the German wine market, i.e. a strongly differentiated

[13] Objective food quality for other food products, e.g. meat, is often defined as the sum of all nutritional–physiological, sensory, processing–technological and hygienic–toxicological characteristics of a food product.

[14] One exception is Bowman and Ethridge (1992).

Table 5 Selected empirical studies of product characteristics in the agricultural and food sector — methods and results

Author	Commodity	Methodology	Significant influence of subjective (S) or objective (O) quality
Ladd and Suvannunt (1976)	31 food items	Hedonic price model	O: Strong influence of various nutrients on food product prices
Morgan, Metzen and Johnson (1979)	Breakfast cereals; US market	Hedonic price model	O: Nineteen dietary components, type of processing, other product characteristics; S: Firms
Hayenga *et al.* (1985)	Hogs; carcass value	Hedonic price model	O: Influence of carcass weight, back fat thickness, muscling index
O'Connell (1986)	Carcass lamb market; Paris	Hedonic price model	O: Carcass weight, fat, presentation index, fat colour, lean colour; S: Country of origin
Veeman (1987)	Wheat; world markets	Hedonic price model	O: Protein, colour; S: US, Canadian and Australian origin
Larue (1991)	Wheat; world markets	Hedonic price model	O: Protein content, test weight, ash; S: US, Canadian and Australian origin
Bowman and Ethridge (1992)	Cotton; US market	Hedonic price model and demand and supply functions for characteristics	O: Trash content, colour, length, strength, low or high micronaire
Brockmeier (1993)	Fruit juice; German market	Hedonic price model	O: Nutrients; packaging; S: Firms; O/S: Flavour
Price *et al.* (1994)	Cereals; dairy products; meat, poultry and fish products; US market	Hedonic price models	O: Nutrients, type of grain and processing; O/S: Other cereal characteristics (e.g. flavour); S: Store size, region

Source: Own compilation.

market. In this study, the links between wine quality, wine prices and demand are analysed. Price and quantity data at the wholesale level have been utilised as well as various survey results as indicators of either objective or subjective quality. Sensory quality of the wines has been evaluated by wine experts on the basis of the five-point scheme of the Deutsche Landwirtschaftsgesellschaft. In this scheme, the overall evaluation of sensory quality is derived from the arithmetic mean of the components odour, taste and harmony of a wine. This evaluation of sensory quality can be interpreted as objective quality since the experts assess the wine characteristics without relying on personal preferences. Furthermore, wine traders have evaluated the publicity and image of the wines in a separate survey. It is well known that publicity and image of brands affect the subjective view of consumers on product quality, i.e. subjective quality. Moreover, the design of the wine packaging was evaluated in a survey of advertising experts who are in direct contact with wine consumers. Again, it is expected that the design variable is an argument of subjective quality for wine consumers.

Table 6 presents selected results of the study by Seidemann (1998). The hedonic price equation 1 in table 6 refers to a sample of 194 wines from various countries in the market segment up to 10 DM per litre on the German market at the wholesale level. When only the sensory evaluation and the assessment of the design are introduced as explanatory variables, the most striking result is that the sensory evaluation of experts does not affect price differences across wines, whereas the design assessment does. This suggests that it is subjective rather than objective quality which matters for the explanation of wine price differences in a broadly defined wine market.

This finding is further confirmed when image variables are additionally introduced. Equation 3 in table 6 shows that wine prices increase significantly with the following:

- a better evaluation of the design of the wine packaging;
- an improved image of the producer type;
- a rising image of the product class of the wine.

This is consistent with the theoretical expectation that design and image are viewed as quality signals by the consumers. They determine subjective quality. Prices do not rise, however, with the experts' sensory evaluation of the wines, i.e. objective product quality. The latter result remains valid in more comprehensive hedonic-price model specifications with additional image and publicity variables, which further raise the corrected coefficient of determination of the model.

The result of a lack of relationship between objective wine quality and prices seems to be only partly consistent with the results of earlier studies. It

Table 6 The influence of quality on wine prices and demand in Germany[a]

	Dependent variables			
Independent variables/ test statistics	Wine prices, all wines (1)	Wine prices, French red wines (2)	Wine prices, all wines (3)	Wine demand, all wines (4)
Constant	− 1.1917 (− 1.13)	− 18.9018** (− 4.20)	− 4.2360*** (− 4.34)	− 1 755 300* (− 2.57)
Sensory evaluation	0.0655 (0.22)	2.6661** (3.89)	− 0.0833 (− 0.33)	116 917 (1.00)
Design assessment	2.7214*** (7.27)	8.1687*** (4.95)	2.0245*** (6.08)	33 111 (0.16)
Image of the producer type			0.7237*** (3.79)	83 757 (0.68)
Image of the product class			1.1488*** (5.56)	
Publicity of the brand				2 249 516*** (16.61)
Publicity of the product class				214 592** (2.88)
Image of the brand				− 1 086 052*** (− 5.79)
Estimated price				− 95 976 (− 1.39)
$\bar{R}^2$	0.21	0.72	0.43	0.75
F	26.65***	16.61***	36.15***	59.37***
n	194	16	194	194

Notes:
[a] The sample consists of wines in the market segment up to 10 DM at the wholesale level. Variables are explained in the text.
*** (**, *) indicates the 99.9 (99, 95) per cent level of statistical significance, respectively. Numbers in parentheses are t-values. $\bar{R}^2$ is the corrected coefficient of determination, F is the F-value. The wine demand equation 4 incorporates more shift variables than presented here. It is the 2SLS estimate of a simultaneous wine market model that also covers a wine supply function. Only significant demand shifters and the sensory and design evaluation are incorporated here.
Source: Seidemann (1998).

is similar to the finding of Nerlove (1995, p.1714) for the Swedish wine market that tasters' overall evaluation is a positive, but insignificant factor.[15] Gabbert, Schamel and von Witzke (1997), however, conclude in their study of US data that 'sensory quality is an important utility-generating attribute

[15] It is not the aim to comprehensively survey the hedonic pricing literature in the context of wine. Further important wine studies include Golan and Shalit (1993), Oczkowski (1994) and Combris, Lecocq and Visser (1997).

for consumers'. They concentrate on a limited sample of vine varieties, i.e. Cabernet Sauvignon and Chardonnay. The sample of wines in table 6 covers a much broader variety, i.e. red and white wines from various grapes, which is certainly more difficult to compare from the consumers' points of view. The results of table 6 may be compatible with the findings of Gabbert *et al.* in the sense that objective quality might matter for price differences in relatively small market segments, but not for the whole and strongly differentiated wine market. In this context, equation 2 in table 6 shows, for the narrow selection of French red wines, that the sensory evaluation as well as the design assessment affect wine prices in a way which is significantly positive.

Equation 4 shows, based on a simultaneous wine market model and a 2SLS estimation of the market demand function,[16] that wine demand is not significantly affected by the sensory wine evaluation, i.e. objective product quality. Wine demand is measured as annual sales of the best selling wines at the wine grower's level in litres; these quantity data are available from a producer survey. Wine prices are wholesale prices in DM per litre. The design assessment, which has strongly affected wine prices, does not represent a significant determinant of wine demand either. However, about 75 per cent of demand variation across wines can be explained by equation 4 via other factors. The most important explanatory variables are publicity and image variables. The publicity of a brand and of a product class raises wine sales strongly whereas a rising image of the brand causes a decline in demand. The negative influence of the brand image on sales may look implausible at first sight. The image of brands has been evaluated by wine experts, however, and may in several cases be unknown to the average wine consumer. Consumers might reduce demand due to a higher price which is associated with the high image of a brand and is more obvious for them than the quality image of the brand. Equation 4 can be interpreted as follows. Across a broad variety of wines in the German wine market, familiarity with

[16] It is not the aim of this article to discuss all details of the supply-and-demand model for wine. A careful discussion would be necessary for each variable of the model why it is included in either the demand or the supply function or both. For details and a comprehensive specification search, see Seidemann (1998). Only the demand function of one simultaneous model is included here as equation 4 of table 6, and a brief explanation of the idea shall suffice. The simultaneous market model for wine implies that prices are determined competitively by demand and supply. Some variables affect wine supply as well as wine demand like the wine price and the sensory evaluation. Sensory evaluation is not only a demand shifter; it will also be associated with marginal costs. We posit that other variables shown in table 6 such as design assessment, the image of the producer type or the product class are indicators of subjective wine quality and are only demand shifters. Dummies for producer types (cooperatives, small wineries, etc.) may be interpreted as indicators of varying marginal costs, i.e. as supply shifters.

brands and product classes as well as the image of brands are used as a quality and/or price signals. These are more important explanatory variables for sales than objective quality as measured in the sensory evaluation.

We may generalise as a hypothesis to be tested in future demand analyses: in differentiated markets, where quality uncertainty exists for the average consumer, subjective quality indicators seem to dominate over objective quality as demand shifters.

5. Conclusions

Food demand analysis is dominated by the econometric estimation of demand systems based on aggregate market data. Due to this methodological orientation, some issues which are important in understanding recent consumption trends in industrialised countries have been widely neglected. We focused on three of these issues: (i) food demand at the retail level; (ii) health information and food demand; and (iii) the influence of product quality on food demand. Major results are the following:

1. It is often argued that changes in food demand become more associated with changes in preferences rather than changes in income and prices. We can conclude from the empirical evidence of retail demand functions, however, that the stylised fact of a price-inelastic food demand cannot be generalised to all demand levels. A price-inelastic aggregate demand for food seems to be combined with a rather price-elastic demand for foods at the level of retail stores. Price elasticities of retail demand are crucially affected by the way price changes are communicated inside and outside the stores. In order to understand market structures in the food sector and their developments, it is a challenge for future demand analysis to utilise scanner data and to elaborate consumer behaviour in more detail, including the timing of purchases, brand-switching, etc.
2. Based on the German National Food Consumption Study, it was possible to explain food demand and food quality by income, sociodemographic variables, and attitude and knowledge variables. Attitude and knowledge variables have typically been subsumed under a constant preference structure in demand analyses before. It could be shown that sociodemographic variables as well as health and diet information significantly affect food consumption. General education, even more than nutrition-specific knowledge, plays an important role in explaining the cross-household variation of food consumption and food quality.
3. In the third section, we investigated whether it is more subjective or objective quality which explains price differentials and demand for a

differentiated product like wine. Due to data limitations, hedonic price models have emphasised the influence of measurable nutrients on food prices. It was elaborated for wine that the objective sensory evaluation by wine experts could not explain price differences across wines, whereas the more subjective assessment of bottle design does. Wine demand is again better explained by subjective quality indicators like familiarity with brands and product classes than the sensory quality as evaluated by experts.

All the presented results were derived from large and unconventional data sets: (i) scanner data; (ii) a very detailed household survey; (iii) the combination of market and survey data to account for objective and subjective quality components. The analysis of such data sets opens new fields for demand research. A much richer explanation of observed consumer behaviour is possible than with aggregate time-series on food consumption.

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