PREFERENCE HETEROGENEITY AMONG GERMAN CONSUMERS REGARDING GM RAPESEED-OIL

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Preference Heterogeneity among German Consumers regarding GM Rapeseed-Oil

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Paper Content:

Consumer acceptance is a determining factor for the profitability and the development potential of GM food. Therefore, using the example of rapeseed-oil this paper investigates German consumer's acceptance towards GM food using a discrete-choice-experiment and latent class analysis. It was possible to identify three different consumer segments. The first cluster comprises consumers who set special value on organically produced food products, while for the second group of respondents cheap prices are the most decisive purchase criterion. The third segment of consumers prefers GM rapeseed-oil with associated health benefits. Furthermore, the defined consumer groups differ in terms of attitudinal variables.

1 Introduction

The cultivation of rapeseed was not very interesting for the agricultural sector for a long time, since it was difficult to use the seeds due to the presence of glucosinolates. However, with the implementation of new conventional methods making it possible to breed new varieties, which do not contain these ingredients, the cultivation of rapeseed increased worldwide (TransGen 2009). In the year 2008/09 Germany was the biggest rapeseed producer in the EU-27 and one of the biggest in the world (Lfl Ernährungswirtschaft et al. 2009). In Germany the cultivated rapeseed is predominately processed to rapeseed-oil, of which one part is used to produce cooking-oil. Looking at the German cooking-oil market it can be observed that the market share of rapeseed-oil steadily increased in recent years. From 2003 to 2007 an extension from 4.9 % to 11.2 % of the used cooking oil could be reached. This is mainly due to a rising popularity of rapeseed-oil among German consumers (Lfl Ernährungswirtschaft et al. 2009).

Rapeseed-oil, which is produced in Germany respectively in the EU, is always a conventional product due to the missing commercial cultivation of GM rapeseed in the European Union (TransGen 2009). In contrast to the EU, in the US as well as in Canada more than 80% of the area cultivated with rapeseed is planted with GM rapeseed. The objectives of GM technology in the field of rape breeding thereby aim on the one hand on the improvement of cultivation properties as well as plant development and on the other hand on the change of product attributes (e. g. change of composition of ingredients, enrichment with special health beneficial ingredients) (TransGen 2009). In Germany and the EU it is not possible yet to buy a rapeseed-oil, which is made from GM rapeseed grown in the EU. But it is feasible that oils made from GM rapeseed as well as rapeseed seeds of approved GM varieties (which will be further processed in the EU) are imported without any restrictions in the EU and are labelled as such (TransGen 2006).

Although tests in the USA have not revealed safety problems deriving from GMOs and GM ingredients in food products, the acceptance towards the application of GM technology in the agro-food sector is still low in the EU - especially among German consumers. In the opinion of most European consumers there is nothing to gain by GMOs, but instead serious disadvantages could occur (Evenson et al. 2004; Gaskell 2006). But for the profitability and the development potential of GM food consumer acceptance is a determining factor. Therefore, the following paper deals with consumer preferences towards a hypothetical GM rapeseed-oil product. Thereby the focus is set on potential preference heterogeneity among German consumers. To investigate this subject the example rapeseed-oil is indeed suitable for several reasons. Rapeseed-oil exhibits a growing popularity among German consumers, whereby it is a marginal processed product. Because of this it might be relatively easy for respondents to establish a relationship to the raw commodity rapeseed. In the same time the number of purchase-relevant characteristics is limited reducing the survey requirements on the respondents (Hartl 2007). Additionally, the product is suitable to analyse consumer preferences towards GM food with associated environmental benefits and with associated health benefits at the same product, since rapeseed can be genetically modified in terms of environmental as well as health benefits.

To analyse and explain preference heterogeneity among German consumers regarding GM rapeseed-oil the paper on hand is structured as follows: First of all a short literature review gives an overview of studies dealing with consumer

acceptance of GM food products as well as preference heterogeneity towards such products. This is followed by a description of the theoretical background and the survey set up to investigate the subject. After this the results of the survey are presented. On the basis of the obtained results the paper will finally give recommendations regarding special marketing activities for the identified consumer segments.

2 Consumer acceptance of GM food products and preference heterogeneity

In recent years several studies dealt with consumer acceptance towards GM food products. Thereby, different influencing variables could be identified. A number of studies document that predominately the perceived utility and the perceived risk have an effect on the acceptance of GM technology. Thereby, the acceptance and the probability to consume a GM product is especially reduced if a distinct perception of the risk associated with this technology exists (Frewer et al. 1998; Bredahl 2001; Lusk et al. 2005; Christoph et al. 2007). In contrast the perceived utility of a product mainly causes the acceptance of a GM food. The higher this perceived utility is for the consumer, the higher is the acceptance of the product (Brown et al. 2003; Bredahl 2001; Gaskell et al. 2004). Thus, GM plants and derived food products comprising no direct advantage for consumers are rather rejected. Contrary, products providing a clear personal advantage for consumers are more likely to be accepted. Brown et al. (2003) were able to demonstrate that consumer perception of risk associated with eating GM soybeans is less in the presence of a perceived consumer benefit (contain omega-3-fatty acids). Other authors come to similar results (Hu et al. 2004; Menrad 2000; O'Connor et al. 2006; Costa-Font et al. 2008).

A further factor influencing the acceptance of GM food products is “information”. Regarding this subject literature reveals different results. It could be shown that information can make consumers more confident concerning GM food and that the effect of information varies by type of information and location. Other studies conclude that existing attitudes towards GM technology significantly effect how individuals respond to new information (Frewer et al. 1998; Lusk et al. 2004; Scholderer et al. 2003). Further studies can show the influence of personal values on the acceptance of GM food. Dreezens et al. (2005) could show that respondents who scored high on the value *powe*r rated GM positively while Saher et al. (2006) found that endorsement of ecological and humanistic self-transcendence values was directly related to negative GM attitudes. Additionally, Grunert et al. (2001) could demonstrate by means of a means-end-approach that respondents regard “non-GM” as a value in itself and associate GM products with uncertainty and poor health (Dreezens et al. 2005; Saher et al. 2006; Grunert et al. 2001).

Regarding socio-demographic variables different studies show the same tendencies. Thus, some conclude that often women or elderly are more likely to reject GM food (Burton et al. 2001; Gaskell 2006; Christoph et al. 2007). But additionally, other studies find that the influence of socio-demographic variables is in general low, respectively less than that of attitudinal variables (Hossain et al. 2003; Ganiere et al. 2006).

Several studies additionally deal with the preference heterogeneity among consumers regarding GM food products. Baker (2002) found by means of a cluster

analysis three different consumer segments. Thereby, consumers in the segment that wished to avoid GMOs were best distinguished from consumers in the other two segments on the basis of their belief that GMOs do not positively affect the quality or safety of food products as well as their high level of risk averseness (Baker et al. 2002). Hu et al. (2004) found by means of latent class analysis four different consumer segments in Canada, comprising preference heterogeneity regarding GM bread. Thereby, the obtained segments *value-seeking consumers* and *fringe consumers* are indifferent to GM ingredients in bread, while in contrast the segments *traditional consumers* and *anti-GM consumers* are not willing to purchase GM bread at all (Hu et al. 2004). Rigby et al. (2005) could also identify preference heterogeneity among survey respondents when reconsidering the results of a choice experiment conducted in the UK by means of a mixed logit model. In Ireland four segments of consumers, differing in the acceptance of a hypothetical second generation GM yoghurt, could be obtained. A cluster analysis on the basis of attitudes towards a second generation product revealed an “anti-GM” segment, a cluster specifically rejecting second generation GM products, a further one which is amenable to the notion of second generation products and a last one, which accepts GM food offering specific consumer benefits (O'Connor et al. 2006). In Germany four different classes of consumers could be obtained by means of a latent class analysis on the basis of data from a consumer survey in spring 2005. The classes show strong differences between willingness-to-pay for benefits compared to risk reduction of a GM and a non-GM food product (Christoph et al. 2006). Another study from Germany investigated consumer preferences towards GM rapeseed-oil. By means of a latent class analysis three consumer segments could be identified. Two of these segments are very critical towards GM rapeseed-oil, while the third is without reservation towards such products (Hartl 2007).

3 Description of the theoretical background and the survey

3.1 Discrete choice experiments and latent class analysis

Choice experiments are based on the characteristics theory of products and the random utility theory (Lancaster 1966; McFadden 1973; Louviere et al. 2000). Lancaster (1966) postulated that consumers do not derive satisfaction from a product itself but rather from the product´s characteristics or attributes. These attributes are usually quantified by a specific set of attribute levels. The random utility theory assumes that an individual maximizes his utility when choosing between alternative products. These fundamental facts are systematically exploited by the choice experiment method. Respondents are confronted with fictitious products composed by different attributes and levels and are asked to choose the product they would buy. By analyzing these data, hence it is possible to assess the relative influence of each attribute and level on the choice (Louviere et al. 2000; Hensher et al. 2005).

One sophisticated extension of the standard analysis of choice experiments for the purpose of respondent segmentation is the latent class analysis (LCA). In contrast to a one-class model which is based on a conditional logit model, latent class analysis assumes that individuals belong to different latent classes that differ in terms of the observed parameters (Kamakura & Russell 1989). In order to take into account that

the choice probabilities depend on the class membership *c*, the logistic model used in latent class analysis is of the form

$$\Pr_{in}(c) = \frac{\exp(V_{in})}{\sum_{j=1}^{J}\exp(V_{jn})} = \frac{\exp(X_{in}ß_{ic})}{\sum_{j=1}^{J}\exp(X_{jn}ß_{jc})} \qquad (1)$$

whereas $\Pr_{in}$ is the probability of individual *i* choosing alternative *n* and V_{in} is the observable utility, which is a function of X_{in} and β_i and an unknown parameter vector to be estimated. X_{in} defines (i) a matrix of attributes that pertain to choice options, (ii) a matrix of characteristics that pertain to individuals, (iii) a matrix of interactions of attributes with individual characteristics, or (iv) a vector of interactions of individual characteristics with choice option intercepts (Louviere et al. 2000). The difference of the latent class model with reference to the aggregated model is that the logit regression coefficients which can be obtained by means of the maximum-likelihood-method can be estimated class specific. The determination of the appropriate number of segments (*c*) to characterize a given population is not part of the maximization procedure from which the parameter estimates are derived. The standard procedure is to sequentially estimate model parameters for an increasing number of segments *c* (*c* = 2, 3, 4, . . .) until an additional segment does not improve the model fit according to some statistical criteria (R^2, AIC, BIC). The lower the statistics, the better the model fit. Attribute coefficients and p-values (Wald test) can also be calculated in order to reveal significant differences of respondent preferences among classes (Vermunt & Magidson 2005).

3.2 Design of the survey

Consumer preferences of GM rapeseed-oil were investigated in the scope of a cross-European project. There a discrete choice experiment (DCE) was conducted. The data was collected by means of personal interviews from March to April 2007. The interviews were stratified according to income and age. In Germany 319 interviews were conducted with people, which do buy rapeseed-oil and which are mainly responsible for the food purchase of their household. Within the choice experiment interviewees had to make their decision between three alternative rapeseed-oil products. Every product (alternative) was constructed of three attributes. These attributes – price, production technology and origin – were chosen on the basis of literature studies, discussion with projects partners involved as well as a pilot questionnaire. Table 1 summarizes the attributes and attribute levels, which were used in the choice experiment. The attribute “production technology” exhibits four levels: conventional, organic and genetically modified with associated health or with associated environmental benefits. In the case of the associated health benefits it was claimed, that the product is enhanced with beneficial anti-oxidants. In the case of environmental benefits it was claimed, that the product is resistant to the damaging effects of certain herbicides. In the forefront of the actual survey interviewees were additionally informed about both aspects. Therefore it was explained to them to which effects free radicals can lead (e.g.to chain reactions, which can lead to cancers or heart diseases) and how antioxidants can operate against these effects. Additionally they were briefed about the problematic of weeds and that herbicide tolerance can e.g. reduce the amount of herbicide needed.

The price attribute was defined in four levels, too and ranged between 1.25 and 5 Euro per 750 ml rapeseed -oil. Furthermore, the origin attribute was presented in only two levels, which are locally grown and imported.

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

Attribute	Attribute Level	Variable name
Production technology	Conventional	conventional
	Organic	bio
	GM health benefits	GM_health
	GM environmental benefits	GM_envir
Origin	Locally produced	inland
	Imported	import
Price	1.25 €	price
	2.50 €	
	4.00 €	
	5.00 €	

Source: Co-Extra consumer survey, 2007.

Following the choice experiment respondents had to deal with questions regarding their socio-demographic characteristics, their general food purchase behaviour, their attitudes towards GM and organic products as well as their knowledge and trust/confidence in GM. Table 2 summarizes the questions, which are relevant for the estimation of the final latent-class-model.

Table 2: Exogenous variables included in the estimation

Question wording	Variable name	Mean
Please rank the following technologies in terms of risk to human health: GM technology. (where 1=very high risk; 5=very low risk)	Risk_GM	2.33 (n=282)
Regulations will protect people from any risks linked to genetically modified food. (where 1 = strongly agree; 5 = strongly disagree)	Reg_Protect	3.59 (n=313)
Organic products are too expensive. (where 1 = strongly agree; 5 = strongly disagree)	Expensive	3.88 (n=319)
I am concerned about the effects of agriculture on the environment. (where 1 = strongly agree; 5 = strongly disagree)	Env_eff	3.19 (n=319)

Source: Co-Extra consumer survey, 2007.

4 Results of the survey

Overall, 319 people participated in the survey. Table 3 summarizes some key data of the socio-demographic characteristics in the sample. It shows that women are overrepresented in the sample compared to the distribution in the German population (2007: 49 % women, 51 % men) (Statistisches Bundesamt 2009). This is mainly due to the fact that the interviewees should be persons, who are mainly responsible for buying food in the household.

Table 3: Key data of socio-demographic characteristics in the sample

		% of sample (n=319)		% of sample (n=319)
Age	18-25 years	24.45	26-40 years	23.51
	41-65 years	27.27	> 65 year	24.76
Gender	male	22.26	female	77.74
Household income	< 833 €	16.93	833-1,666 €	42.32
	1,667-2,499 €	21.94	2,500-3,333 €	12.23
	> 3,334 €	6.58		

Source: Co-Extra consumer survey, 2007.

Table 4 shows the results of a 3-class-solution of the latent class model. The AIC and BIC value amount to 2,843.301 and 2,933.538 respectively. The coefficient of determination (R^2), which is also a measure for the model´s adjustment quality, results in a value of 0.52. Thus, a clear improvement of the quality measures could be achieved by the latent class analysis opposite to a 1-class-solution (Vermunt & Magidson 2005). Also a solution with four segments would not improve the model estimation significantly.

The p-values of the attributes price, production technology and origin confirm the existence of significant (p-value < 0.05) parameter differences between the three groups. The consideration of attitude variables in the model estimation however shows only for the covariates „Regulations will protect people from any risks linked to genetically modified food.“, „Organic products are too expensive.“, „I am concerned about the effects of agriculture on the environment.“ and „the general risk evaluation of GM technology“ a significant contribution to the distinction between the different groups. In the following the three identified groups are described in detail.

Class 1: Buyers of organic food products

The *buyers of organic food products* represent the largest group with 42.0% of all 319 respondents.

On the basis of the attributes` relative importance it can be stated that in this group the attribute *production technology* has the largest influence on the consumers´ preference (71.5%). Thereupon, *price* and *origin* follow with large distance (19.7% or 8.7% respectively).

Regarding the levels of the different attributes, for *price* it can be noticed that class 1 prefers lower price levels. The z-value (-4.902) indicates that the price is classified as worse, the higher it is. Thus, this result permits the conclusion that for this group price not necessarily acts as a quality indicator.

Besides, consumers of this cluster are rather willing to buy food products which are inland produced (z-value: 4.616).

Concerning the attribute *production technology* this segment definitely prefers organically produced food products (z-value: 17.110), which is the reason for naming this cluster “buyers of organic food products”. Additionally, still accepted are conventionally produced food products (z-value: 12.113). GM food products however are rejected – regardless whether they feature health or environmental benefits (z-values: -8.432 and -8.247 respectively).

Regarding the covariates, which were also included in the model estimation in order to enable a more detailed characterization of the different classes, it can be stated that the members of group 1 in principle classify GM technology as very risky. Besides they disagree that laws and regulations can protect humans against the risks of GM technology. Furthermore, they are concerned about the consequences, which agriculture poses for the environment. Despite their rather price-sensitive attitude, they nonetheless think that organic food products are too expensive.

Class 2: Low-price-buyers

Class 2 (*low-price-buyers*) comprises 31.1% of all respondents.

Contrary to class 1 *price* is the most decisive attribute (72.6%) for this cluster, whereas with 15.7% or 11.7% respectively a by far smaller importance for the decision making is attached to *production technology* and *origin*.

However, the results of this cluster comply with those of cluster 1 regarding the evaluation of different attribute levels. Thus, also the *low-price-buyers* rather prefer low prices (z-value: -7.849) as well as organically and inland produced food (z-value: 3.846 or 4.175 respectively).

The generally strong relevance of the attribute *price* for the decision making of these consumers as well as the preference for low prices is nonetheless crucial for the designation of this group as *low-price-buyers*.

Although organic food products are theoretically preferred by these consumers, they also hold that organic food products are too expensive - a result, which supports the characterization of this group as *low-price-buyers*.

Contrary to the very risk-sensitive *buyers of organic food products, low-price-buyers* hold the view that GM technology does not has any specific risks, and that laws and regulations are able to protect humans from yet potentially existing risks of this technology. In addition they do not believe that agriculture has negative effects on the environment.

Class 3: Buyers of GM products with associated health benefits

With 26.9% of all 319 respondents class 3 (which contains the *buyers of GM products with associated health benefits)* represents the smallest group.

Considering the relative importance of the different attributes responsible for the consumers´ preferences one can observe that for this group *price* (24.5%), *production technology* (36.6%) and *origin* (38.9%) all constitute nearly the same relevance.

Also in this cluster the consumers (as in the two other groups) are rather attached to low prices (z-value: -3.487) and inland produced food products (z-value: 7.447). However, it is the only group, which definitely prefers GM products with associated

health benefits (z-value: 4.950) compared to other products. From this fact also the designation of this segment as *buyers of GM products with associated health benefits* results.

Regarding the covariates it is noticeable that all attitude variables show insignificant z-values except one. The consumers of this cluster do not think that genetic engineering is a risky technology.

Table 4: Results of the 3-cluster-solution of the latent class model

	Class 1		**Class 2**		**Class 3**		
R^2(0)	0.63		0.62		0.17		
Class size (%)	42.0		31.1		26.9		
Relative Importances (%)							
Price	19.7		72.6		24.5		
Production technology	71.5		15.7		36.6		
Origin	8.7		11.7		38.9		
Attribute/ Level	**Coef.**	**z-value**	**Coef.**	**z-value**	**Coef.**	**z-value**	**p-value**
Price							0.000
	-0.323	-4.902	-1.366	-7.849	-0.178	-3.487	
Production							0.000
Conventional	1.437	12.113	-0.149	ns	-0.505	-4.779	
Organic	2.419	17.110	0.650	3.846	0.209	2.359	
GM: Health benefits	-1.889	-8.432	-0.044	ns	0.490	4.950	
GM: Environmental benefits	-1.967	-8.247	-0.457	-2.560	-0.194	-2.108	
Origin							0.011
Locally produced	0.267	4.614	0.411	4.174	0.528	7.447	
Imported	-0.267	-4.614	-0.411	-4.174	-0.528	-7.447	
Reg_Protect							0.000
	-0.496	-4.327	0.376	3.209	0.121	ns	
Risk_GM							0.000
	-1.008	-6.387	0.539	3.959	0.468	3.709	
Expensive							0.002
	-0.343	-2.785	0.409	3.352	-0.067	ns	
Env_Eff							0.000
	0.425	4.118	-0.365	-3.101	-0.059	ns	

ns = not significant

Source: Own depiction.

5 Discussion of the results

The results of the survey indicate that three consumer groups exist in Germany which show different preferences towards GM rapeseed-oil. The biggest segment (42%) – *buyers of organic food* – does not accept GM rapeseed-oil at all and estimates GM technology as very risky. The segment *low-price-buyers* (31%) is clearly opposed to GM rapeseed-oil with associated environmental benefits. This is also true for the third identified class (27%). But this class exhibits preferences towards GM rapeseed-oil with associated health benefits. Thus, the survey demonstrates that only a minority of German consumers has a positive opinion of GM products and furthermore only if they comprise personal advantages (i. e. health benefits). In contrast the majority of German consumers prefer conventional or organically grown products. They do not accept GM food – especially, when the genetic manipulation leads to no evident personal advantages.

The results obtained in this survey show consistency with other existing studies dealing with preference heterogeneity towards GM food. Baker et al. (2002) revealed also one segment, which is opposed to GM products and with a high level of risk averseness. Additionally, O'Connor et al. (2006) found that the majority of the Irish population is opposed to such products, while only a smaller group prefers GM products offering specific consumer benefits. A work of particular interest is additionally the study of Hartl (2007), which was conducted in Germany and dealt with rapeseed-oil. He also found two segments being opposed to GM rapeseed-oil and one with no reservation. The group sizes are comparable to that in the study on hand: The biggest segment (42.3%), which he obtained, rejects GM rapeseed-oil very much, whereas the safety aspect of GM is very important for the class members. In the study of Hartl (2007) the segment without reservation is with 26.4% of the sample similar in size as the one in the study on hand.

Regarding socio-demographic variables no significant effects could be observed, while in contrast attitudinal variables constitute influences. This is consistent with the findings of other studies, which concluded that the influence of socio-demographic variables is in general low respectively less than that of attitudinal variables (Hossain et al. 2003; Ganiere et al. 2006).

Whereas the three clusters show noticeable differences regarding their preferences towards the *production technology* used for the rapeseed-oil, they do not at all differ in their preferences towards *price* and *origin*. All segments prefer locally produced and cheap rapeseed-oils.

In the case of *price* one would expect that there are some consumers who use this attribute as a quality indicator and therefore look for high-price products (particularly as rapeseed-oil is considered as a very high-quality oil). However, the result that low-priced products are preferred indicate that mostly consumers were interviewed for whom oil is rather a low-involvement product and therefore are not aware of the premium qualities of rapeseed-oil.

The result of this study that the designation of a local origin affects consumer preferences towards a product in a positive way can be confirmed by other studies for products like for instance beer or beef (Profeta 2006) and especially for rapeseed-oil (Hartl 2007). Consequently, Hartl (2007) shows that consumers' utility significantly increases if the analysed rapeseed product is grown within Germany. Also, Banik and Simons (2008) found a group of rapeseed-oil consumers trusting in local food and perceiving food labelled with its origin as of higher quality and health-

related value than comparable, non-local food.

In order to reach potential consumers of GM rapeseed-oil (cluster 3) by means of marketing activities it is of special importance to highlight the GM product´s benefit in terms of consumer health. This can be implemented either by corresponding advertising strategies or with a corresponding health claim. In contrast consumers rejecting GM rapeseed-oil (cluster 1) seem to have substantial concerns towards GM products - independently whether they are associated with health or environmental benefits. Therefore, it will hardly be possible to convince these consumers of GM food e. g. by means of special information campaigns.

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