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Willingness to pay for genetically modified food and non-food products

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Abstract

This paper presents estimates of consumers' willingness to pay for a GM food and non-food product based on data collected in a choice experiment. The choice experiment was part of a survey of 1510 randomly selected consumers in Germany that was mailed in spring 2005. Attitudes towards gene technology, institutions and technical progress were measured using 22 items. A factor analysis revealed five factors describing consumer attitudes: support, risk, trust, attitude towards technical progress and attitude towards technical innovation. Based on these factors we identify four different classes of consumers in a latent class model for both products. Analysis of these classes shows strong differences between willingness to pay estimates for benefits compared to risk reduction as well as differences between the classes.

Introduction

Gene technology is controversially discussed around the world. Especially genetically modified (GM) food is vehemently refused by many consumers all over Europe, particularly in Germany (Gaskell et al., 2003). Asked about GM foods, 71% of the respondents of the Eurobarometer 2001 answered that they do not want this type of food and even more (95%) agreed with the statement "I want to have the right to choose". Only 15% agreed that "this kind of food does not present any particular danger" (European Commission, 2000). The degree of opposition is not homogenous over all European countries, though, and changes over time. In Spain, Portugal, Ireland and Finland GM food was less opposed than in the other countries during the years 1996-1999. Since 1999 GM food experienced increasing support in the majority of European Countries while the situation remains stable in Germany and Finland and support declined in Italy, France and the Netherlands (Gaskell et al., 2003).

The facts mentioned above, however, do not imply that consumers are anti-science in general. Consumers in the UK, France, Spain, Italy and Germany are found to be neither "anti-science" nor asking for a "risk-free" technology. Their questioning of GM food seems to be influenced by uncertainty about possible long-term effects on the environment and on human health. And because of this, they raise questions about the distribution of benefits of the new technology between producer and consumer (Marris et al., 2001). They notice producer benefits but are unable to detect own ones (Marris et al., 2001). Noussair et al. (2002) found out that even if consumers accept GM products, a lower price of those products is needed to make consumers willing to buy them.

During the last years, new GM plants with special output traits entered the market (Lheureux et al., 2003). These plants differ from former GM plants since not only producers benefit but also consumers. These plants have, e.g., higher nutritional values (potatoes, rice) or longer storability. The question of interest is if consumers are aware of these benefits and if they then still reject GM products. It is finally the question if consumers pursue a utilitarian trade-off between risks and benefits with regard to genetic modification of plants.

This paper assesses consumers' risk benefit analysis. Willingness to pay (WTP) for a GM food product (French fries) and a non-food product (paper) will be estimated using data collected in a Choice Experiment. While most former studies analyzing GM products have focused either on food or non-food products, our study examines both products where both are produced from the same plant, a GM potato. WTP is estimated in a latent class modelling approach where psychometric data is used in estimating the underlying classes of consumer types. As psychometric data we used consumers' attitudes towards biotechnology. The data was collected in a survey of 1510 German households in spring 2005.

Following this introduction, we present our methods and model. Then results are presented and discussed and the paper concludes.

Data

Survey design

The analysis is based on a survey that was mailed to 5,000 randomly selected adults in Germany in spring 2005. To detect negative effects because of possible media reports during the answering period, respondents were requested to mention the day of filling in the questionnaire. Consumers were informed that the research is not sponsored by a biotechnology supporting or rejecting organisation. Respondents are asked 22 items to measure their attitude towards biotechnology. After that WTP questions in form of a choice experiment were asked for a food product as well as for a non-food product. For a better comparison of the found classes respondents knowledge about biotechnology is measured by a number of true and false questions and their acceptance of biotechnology in different application areas (medicine, food production and industrial production) is evaluated. In the end sociodemographic variables are collected.

Methods

Choice Experiment

A choice experiment (CE) is a type of stated preference method that arose from conjoint analysis. In contrast to the latter the respondents do not rank or rate the different alternatives, they are asked to choose one among several alternatives proposed to them. The products used in this choice experiment for WTP estimation were French fries and paper both produced from GM potato. These products were chosen for several reasons. First, we wanted evaluate whether there is a difference between the willingness to pay for GM food and non-food products. Second, both products are associated to benefits and risks because of genetic modification. Since they originate from the same plant, some of the risks and benefits are the same. In addition, both (conventional) products are widely known and used by German consumers. Furthermore potatoes are of considerably importance in German agriculture.

A CE describes the alternatives to choose from using a number of attributes. The attributes selected for the CE are listed in table 1. For French fries we included a fat reduction in the end-product and a pesticide reduction as potential health and environmental benefits. In addition a potential health risk is introduced that emanates from an antibiotics antigen remaining in the potato. Spreading of the modified plant in nature is included as an environmental risk. The last attribute was price.

For paper, an energy-saving production process in starch separation and a pesticide reduction were taken as potential environmental benefits. The potential risk is spreading of the modified plant in nature. Price was included as an attribute as well. Table 1 shows the mentioned attributes with the used levels which were chosen based on evidence in the scientific literature.

Table 1: Attributes and attribute levels for the WTP estimation

	Paper 100 sheets		**French Fries 750g package**	
	Attribute	Levels	Attribute	Levels
	Price (in Euro)	0.89 - 0.99 - 1.09	Price (in Euro)	0.99 - 1.09 - 1.19
Risks	Risk of spreading	0% - 1% - 3%	Risk of spreading	0% - 1% - 3%
			Antibiotics Antigen	0% - 10% - 50%
Benefits	Energy saving	0% - 20% - 60%	Fat reduction	0% - 20% - 50%
	Pesticide reduction	0% - 5% - 20%	Pesticide reduction	0% - 5% - 20%

The choice scenarios were constructed using a 3^5*3^5 for French fries and a 3^4*3^4 orthogonal main-effects design for paper. In each case 27 product combinations were found. Combinations with an obvious favourite (e.g., identical products with different prices) were excluded from the CE. In the end, 20 choice scenarios remained for French Fries and 19 for paper. To facilitate the choice task, each respondent received four choice questions for each product. An example question from the CE is given in figure 1. The products A and B are GM French fries while product C is not genetically modified.

Option A and B represent two different descriptions for GM French Fries. Please check the option (A,B, or C) that you would be most likely to purchase.			
Product attribute	**French Fries A**	**French Fries B**	**French Fries C**
Price	1,09€	1,19€	1,09€
Fat intake	unchanged	20% less	
Antibiotics Antigen	Health Risk of 10%	Health Risk of 0%	conventional and unchanged
Pesticide reduction	5% less	unchanged	
Risk of spreading	3%	0%	
I would choose......	☐	☐	☐

Figure 1: Sample choice experiment question

Latent Class

The latent class model is an approach to account for preference heterogeneity among consumers. Based on observed (hypothetical) choices consumers are grouped into classes. In this application heterogeneity is explained by the results of a factor analysis on consumers' attitudes towards biotechnology. The presentation of the latent class model follows Boxall und Adamowicz (2002) und Greene and Hensher (2002).

Individual n chooses alternative i resulting in utility $U_{ni} = U(X_{ni})$, where X_{ni} is a vector describing the attributes embedded in alternative i. Applying McFadden's random utility model, utility is composed of a deterministic and a random part: $U_{ni} = V_{ni} + \varepsilon_{ni}$. Here $V_{ni} = f(X_{ni})$ is deterministic and depends on the product attributes whereas ε_{ni} presents the random component.

The individual has to choose one alternative among those listed in the choice set, C. The probability ($\pi_n(i)$) of choosing alternative i, equals the probability that alternative i leads to the maximum utility of all alternatives of choice set C. That is:

$$\pi_n(\mathrm{i}) = \mathrm{Prob}\,\{\, V_{ni} + \varepsilon_{ni} \geq V_{nk} + \varepsilon_{nk}\,;\, i \neq k, \forall k \in C \,\}.$$

The multinomial logit model can be used to estimate these probabilities under the assumption that the error term is following the extreme-value-type-I distribution.

Substituting a linear functional form of product attributes into the deterministic utility part, the probability results in a multinominal logitmodel

$$\pi_n(\mathrm{i}) = \frac{\exp(\mu\beta \mathrm{X}_i)}{\sum_{k\in C}\exp(\mu\beta \mathrm{X}_k)}$$

Here μ is a scale parameter, normalized to unity and β is a vector of parameters to be estimated.

In the traditional multinomial logit model, a common vector β is estimated for all individuals. In the latent class model, it is supposed, though, that consumers are heterogeneous. The population consists of S classes or segments. If consumer n belongs to segment s (s=1, 2, ..., S), then the utility function can be specified as follows:

$$U_{ni|s} = \beta_s X_{ni} + \varepsilon_{ni|s}\,.$$

Therefore, parameters are class specific and the likelihood of choosing alternative *i* given that consumer *n* belongs to segment s results as

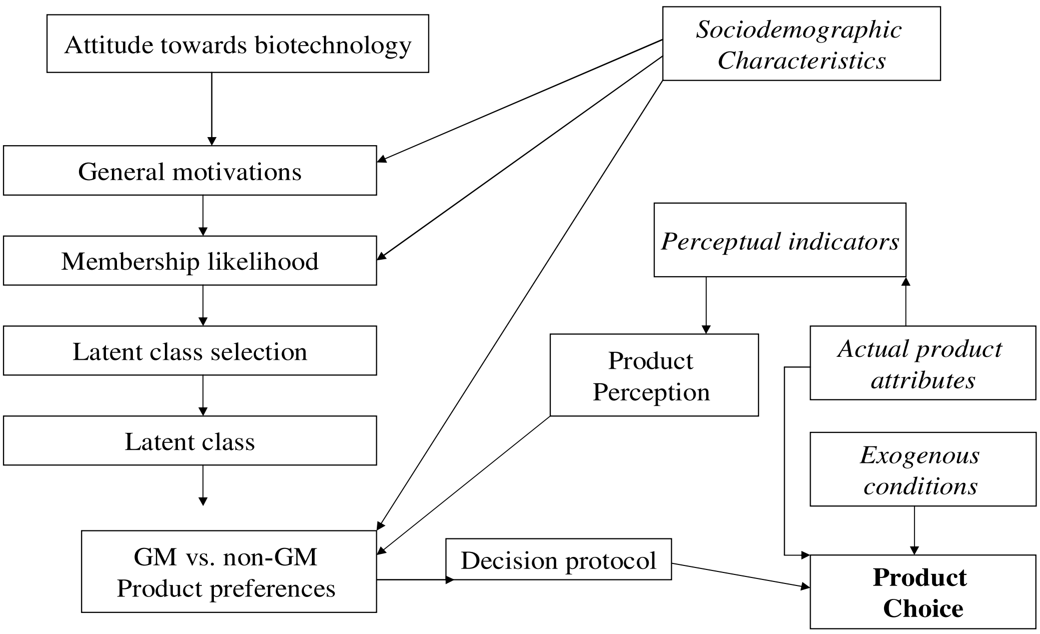
$$\pi_{ni|s}(i) = \frac{\exp(\mu_s\beta_s \mathrm{X}_i)}{\sum_{k\in C}\exp(\mu_s\beta_s \mathrm{X}_k)}$$

where $\beta_s\mu_s$ presents the class specific utility or scale parameter. It is important to note, that the classes are latent, that is they cannot be observed directly. Based on attitudinal factors identified in the factor analysis and possibly based on sociodemographic characteristics, the latent classes can be identified in the estimation procedure. The probability of belonging to a certain class can be specified with a multinominal logit model

$$\pi\,[\text{class=s}] = Q_{ns} = \frac{\exp(\theta'_s\, z_n)}{\sum^{S}_{s=1} \exp(\theta'_s\, z_n)} \quad \text{with } \theta_S = 0$$

Z_n is an optional set of person invariant characteristics. It is possible that the class specific probabilities are a set of fixed constants if there are no other observed characteristics. In our case the class probabilities are simply functions of S sets of parameters, θ_s, where the last one is fixed at zero. We take five factors of a factor analysis on respondents' attitudes towards biotechnology as parameters.

Figure 2 might be used to get a better understanding of the complex structure of the LC model in the context of buying GM products.

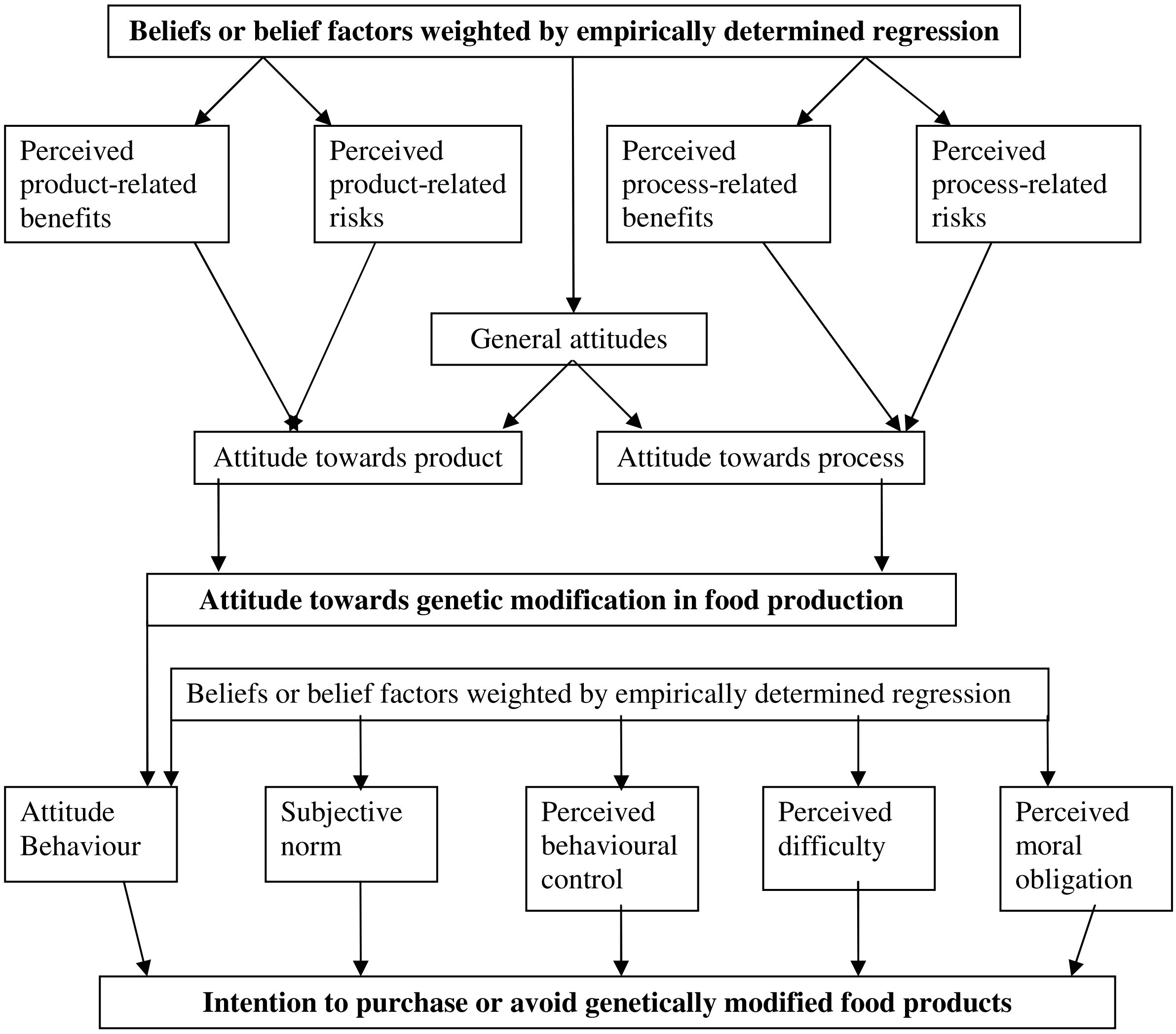


Source: Modified based on Boxall and Adamowitz, 2002.

Figure 2: Diagramm outlining the application of LC choice model for buying GM products

Figure 2 includes latent variables (written normal) and observable variables (written in italics). Latent variables compose the main part of the product choice process. There are several latent aspects that relate to each other and the majority of them are influenced by sociodemographic characteristics even before the product preference is explicitly mentioned. This makes it so difficult to analyse the product choice process appropriate.

In the beginning of our product choice process stands the attitude towards biotechnology. With this attitude we explain the heterogeneity among the consumers. This very complex construct is explained based on a model from Bredahl et al. (1998). With respect to their results figure 3 can be used to explain the complex interrelation of the various underlying aspects that result in the intention to purchase or avoid GM food. Perceived benefits and risk related to the productions process as well as to the product itself have to be taken into account. It should be pointed out that these are the perceived benefits and risks which do not have to be similar to the real ones. These perceived benefits and risks as well as individuals' general attitudes determine their attitude towards the GM product and the production process of that product. In conjunction we specify the attitude towards genetic modification in food. This results in individual's attitude behaviour. This attitude behaviour, individual subjective norms, the perceived behavioural control of the examined situation, perceived difficulties and perceived moral obligations will determine the intention to purchase or to avoid GM products in the end. Especially the moral obligations and subjective norms are the effect of an individual's environment as family, friends, colleagues et cetera.



Source: Modified based on Bredahl et al., 1998.

Figure 3: Attitude and purchase intention model for GM Foods

The attitude to biotechnology is then specified based on a factor analysis. Respondents had to answer 22 statements about risks and benefits of GM products and the used processes, their confidence in governmental regulations and technological development as well as overall questions about food and nature. Statements were taken following the Eurobarometer 52.1, Eurobarometer 58.0, Bredahl et al. (1998) and Noussair et al. (2001). The used five-point Likert-Scale ranged from “I totally agree” to “I do not agree at all”. Statements were pretested in march 2005 by 53 respondents.

An explorative factor analysis was carried out to define the underlying structure in the data matrix (Hair et al, 1998, p.90). To ensure that the sample was suitable for factor analysis the Measure of Sampling Adequacy (MSA) Test[1], Kaiser-Meyer-Olkin (KMO)-Test[2] and the BartlettTest of Sphericity[3] were run out, Cronbach's Alpha[4] was also tested. After that a principle component analysis[5] was carried out using a promax 6 rotation (Hair et al., 1998, pp 99-103).

Results

The questionnaire was mailed to 5000 randomly selected consumers in Germany in April 2005. Respondents were asked to return the questionnaire until a specific date in a prepaid envelope. The response rate was about 30% (1510 completed questionnaires). In the following just those questionnaires included where all questions concerning the attitude towards biotechnology (the mentioned 22 statements) were answered. The analysed sample has a size of 1421 individuals.

Sociodemographics

Table 2 shows some sociodemographic of the sample. Characteristics are shown for Germany as well to allow the assessment of the sample's representativeness.

More male respondents answered than female (52.7% vs. 47.3%) although the questionnaire was sent to the same number of male and female consumers. Almost 73%

[1] Calculated for the entire correlation matrix evaluating the appropriateness of applying factor analysis.
[2] Like MSA but for all variables instead of only one.
[3] Test for the overall significance of all correlations within a correlation matrix provides the statistical probability that the correlation matrix has significant correlations among at least some of the variables.
[4] Measure of realibility.
[5] The principle component analysis should be used if the objective is to summarize most of the original information in a minimum of explaining factors.

have children but only 21.8% had children younger than 12 years. Respondents' mean age is 49.6 years (ranging from 18 to 80 years); persons younger than 18 were not sampled. Median net household income is in the interval of 2000 to 2500 Euros per month.

Table 2: Sociodemographic sample characteristics

Variable	**Definition**	**Mean**	**Germany relative**
Gender	= 1 if female, = 0 if male	0.473	0.511
Age	Age in years	49.59	
Children	= 1 if respondent has children; = 0 otherwise	0.724	
Children younger 12	= 1 if respondent has children under 12; = 0 otherwise	0.218	
Education			
• without degree		0.001	0.0279[2]
• professional training		0.301	0.5050[2]
• university degree		0.275	0.1189[2]
Mean household size	Persons per household	2.54	2.12[2]
Median monthly net household income (Euros)		2000-2500	2833

[1]Federal Statistical Office: Mikrozensus 2004, [2]Federal Statistical Office: Einkommens- und Verbrauchs-stichprobe 2003

Compared to the country Germany the mean household size is larger (2.54 compared to 2.12) and the distribution between males and females is in this survey the other way round (47.3% females compared to 51.1% in Germany). People's education is on average better for the analyzed sample than all over Germany.

Exploratory Factor Analysis

In the beginning the data set was used to get some information about the suitability of the collected data regarding factor analysis. Table 3 shows the results of the goodness of fit tests.

Table 3: Measures of fit for factor analysis

	Value
Cronbach's Alpha	0.885
Bartletts Test of Sphericity	0.000
Kaiser-Meyer-Olkin (KMO)	0.943
Measure of Sampling Adequacy (MSA)	
• Highest level (item:)	• 0.968
• Lowest level (item:)	• 0.876

Cronbach's Alpha measures scales reliability (Brosius, 2002) and can vary between 0 and 1. Hair et al. (1998) recommend at least 0.7, so the reached level of 0.885 is completely acceptable. Bartlett's Test of Sphericity tests overall significance of all correlations within the correlation matrix. The achieved level of zero is very good. While the KMO measures the appropriateness for factor analysis for the entire correlation matrix, the MSA measures this for each statement. For both levels of at least 0.5 are required by Hair et al. (1998), while Kaiser asks for levels above 0.7 (Kaiser, 1970). The found levels of 0.943 for the KMO and levels between 0.876 and 0.968 for MSA can be viewed as absolutely adequate.

After a principle component analysis with promax rotation on level 6, five factors were identified to influence respondents' attitude towards biotechnology[6]. These factors are (1) support (of biotechnology), (2) risks (of biotechnology), (3) trust (in monitoring and institutions), (4) attitude towards progress and (5) negative attitude towards innovation.

[6] The statements and the factor levels are presented in annex 1 as well as the accounted error variances

The first factor (support) is also the most important one and reflects respondent’s opinion about possible benefits of GM products for humans and the environment, the processes used to produce the products and the fact that possible risks are tolerable. Within this factor the statement that ‘GM food is not necessary’ is denied explicitly. The second factor (risk) includes all the associated risks of the products produced using biotechnology, the used process and the fact that some risks might not be foreseen. It has to be pointed out that this factor cannot be equated with opposition of biotechnology. The shown statements asked explicitly for the probability of different risks and not for refusal of GM products. The third factor (trust) reflects respondents trust in scientists, governmental regulations and the food industry. While the fourth factor (attitude towards progress) covers the attitude towards progress in general the fifth factor (negative attitude towards innovation) specifies this attitude for technical innovation.

Latent Class estimation

We used different product attributes for the choice experiment. Potential benefits for French fries were a fat reduction in the end-product and a pesticide reduction. Risks are represented through an antibiotics antigen and spreading of the modified plant in nature. For paper, an energy-saving production process and a pesticide reduction were taken as potential benefits. The potential risk is again spreading. Price was included as an attribute for both products.

Paper

Due to respondents who did not answer any choice questions 1336 respondents are included in the following analysis. We estimated latent class models with 1, 2, 3, 4 and 5 class solutions to find out the appropriate solution. We used ρ^2, Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) to answer that question. Table 4 presents their results as well as those of the log likelihood (LL) and the restricted log likelihood (LL0).

Table 4: Information on the converged latent segment models for the paper estimation

Sets	Parameter	LL	LL0	ρ^2 1-(LL/LL0)	AIC -2(LL-P)	BIC -LL+(P/2)*lnN
1	5	-5043.373	-5555.682	0.092	10096.745	5061.366
2	16	-4745.812	-5555.682	0.146	9523.624	4803.391
3	27	-4675.304	-5555.682	0.158	9404.607	4772.469
4	38	-4633.962	-5555.682	0.166	9343.925	4770.714
5	49	-4607.989	-5555.682	0.171	9313.979	4784.327

Version with four classes can be accepted as suitable that is associated with the minimum BIC value. The AIC is still decreasing but at a lower rate than for a lower number of class, the same holds true for the ρ^2 values.

Table 5 shows the parameter estimates for a simple multinomial logit model and the latent class estimation. Classes were constructed on the five factors identified in the factor analysis. Almost all coefficients to the product attributes are highly significant.

Table 5: Parameter estimates – GM paper

	Full Sample	Class 1	Class 2	Class 3	Class 4
Constant	-0.352*** (0.056)	20.530 (2404.716)	-3.494*** (0.279)	-1.624*** (0.300)	-0.703*** (0.067)
Price	-4.358*** (0.349)	-4.782*** (0.512)	-12.173*** (1.648)	-15.05*** (1.858)	-3.108 *** (0.405)
Risk of spreading	-0.195*** (0.022)	-0.119*** (0.032)	-0.240*** (0.089)	-4.140*** (0.314)	-0.084*** (0.027)
Energy saving	-0.029*** (0.001)	-0.038*** (0.002)	-0.037*** (0.005)	-0.120*** (0.009)	-0.020*** (0.001)
Pesticide reduction	-0.045*** (0.004)	-0.058*** (0.006)	-0.164*** (0.019)	-0.437*** (0.036)	0.004 (0.005)
Theta					
Constant	-	0.035 (0.083)	-3.172*** (0.548)	-1.659*** (0.185)	-
Support	-	0.190 (0.129)	-1.954*** (0.403)	-0.408* (0.234)	-
Risk	-	0.058 (0.106)	0.022 (0.348)	0.339* (0.203)	-
Trust	-	0.108 (0.102)	0.203 (0.261)	-0.193 (0.183)	-
Attitude towards progress	-	-0.200** (0.091)	-0.387** (0.218)	-0.094 (0.150)	-
Attitude towards innovation	-	-0.143* (0.08)	0.198 (0.199)	-0.136 (0.152)	-
Number of respondents	1336	653	78	124	481

*,**,*** presents significance at the 0.1, 0.05, 0.01 level, the standard error is written in parenthesis

The parameters to the attitudinal variables of the fourth class are normalized to zero. Parameters of the other three classes have to be interpreted in relation to this fourth class.

Significant for the first class are the negative attitudes towards progress and innovation. The second class shows a high significant negative value on support of biotechnology and also a significant negative attitude towards progress. Characterizing for the third class is the significant negative value for the factor support in combination with the significant positive value for the factor risk. The fourth class supports biotechnology more than the second and third class. Additional to this, risks are seen to be less possible and/or dreadful. This class has also the most positive attitude towards progress and a positive one for innovation.

Table 6 shows the estimates of willingness to pay for the three classes as well as for the full sample by attribute. Differences between the three segments are pronounced. Especially the third class differs a lot from the others. Respondents belonging to this segment always react stronger than those belonging to the other three.

Table 6: Willingness to pay Euro-Cent for GM paper by attributes

	Full Sample 1336	Class 1 653	Class 2 78	Class 3 124	Class 4 481
Reduction in risk of spreading	5.9 (2.14;25.53)	3.8 (2.50;12.86)	2.8 (1.98;5.87)	24.9 (21.44;27.06)	4.4 (2.28;8.66)
Energy saving	0.7 (0.35;0.80)	0.08 (0.76;0.80)	0.3 (0.30;0.40)	0.8 (0.74;0.80)	0.6 (0.41;0.68)
Pesticide-Reduction	1.0 (-0.13;2.70)	1.2 (0.96;1.85)	1.3 (1.13;1.55)	2.8 (2.41;2.87)	0.3 (-0.14;1.06)

The 90-% confidence interval is written in parenthesis

They are very responsive to the risk of spreading and their willingness to pay decreases by almost 25 Euro-Cent per percentage of this risk. The other classes also react to this risk but less intensively. Respondents from this third segment show the most positive WTP to the possible energy saving and fertilizer reduction. They are willing to pay about 0.8 Euro-Cent per percentage of energy saving what is a bit more than the average of 0.7 Euro-Cent. Their willingness to pay for the mentioned pesticide reduction is more than twice as high as in the other segments. These respondents seem to be very environmentally conscious. Both, risk of spreading as well as pesticide reduction are attributes directly related to the environment while the environmentally protection effect of energy saving is less obvious. This might cause a problem for companies which want to sell argue for genetic modification of potatoes because of this energy saving process. This class has the highest parameter on the attribute price which means that these respondents are very price sensitive. Because of their below average support of biotechnology and their average perceived risks of biotechnology we call them “environmentally conscious opponents”.

The first class has an above average WTP for the reduction of energy and pesticides but do not react strongly on the risk of spreading. In addition with the significantly more negative attitudes towards progress and innovation they can be described as “scepticals of the innovation”.

Respondents belonging to the second class do not differ a lot from those of the first one. They show less support for biotechnology and have a higher WTP for energy saving. Their WTP for the reduction of the risk of spreading is the lowest among all groups. Because of their negative value on support of biotechnology and their negative attitude towards progress we title them as “opponents of technological progress” however they are willing to pay trade-off attributes.

WTP estimates of the fourth class are below average for all attributes. Their small WTP for the risk reduction can be explained by their small levels for the perceived risks of biotechnology. They can be described as supporters.

French fries

Again, four classes were found to be the optimal number of classes. This time, 1396 respondents are included in the estimation. Results of the criteria used for the appropriateness of the four segments solution, the log likelihood and the restricted log likelihood are presented in table 7.

Table 7: Information on the converged latent segment models for the paper estimation

Sets	Parameter	LL	LL0	ρ^2 1-(LL/LL0)	AIC -2(LL-P)	BIC -LL+(P/2)*lnN
1	6	-4563,. 32	-6069.200	0.251	9138.465	4584.957
2	18	-4152.203	-6069.200	0.319	8340.405	4217.375
3	30	-4072.371	-6069.200	0.332	8204.743	4180.992
4	42	-4018.698	-6069.200	0.341	8121.396	4170.767
5	54	-3994.311	-6069.200	0.345	8096.621	4189.827

Table 8 shows the parameter estimates for a simple multinomial logit model and the latent class estimation for French fries. Classes were constructed on the five factors identified in the factor analysis. Classes do not differ as extremely as for paper. Important to note is that the parameter to price is positive but not significant in class 1 and positive and significant in class four.

The attitude towards innovation turns out to be significant in the explanation of class membership.

Table 8: Parameter estimates – GM French Fries

	Full Sample	Class 1	Class 2	Class 3	Class 4
Constant	-1.065*** (0.059)	-2.209*** (0.221)	-0.895*** (0.105)	1.246*** (0.121)	-0.352*** (0.092)
Price	-1.759*** (0.346)	2.135 (1.862)	-10.965*** (0.666)	-2.472*** (0.601)	2.191*** (0.497)
Fat reduction	-0.012*** (0.001)	-0.028*** (0.006)	-0.008*** (0.002)	-0.020*** (0.002)	-0.019*** (0.002)
Antibiotics antigen	-0.037*** (0.002)	-0.306*** (0.056)	-0.152*** (0.01)	-0.042*** (0.002)	-0.019*** (0.002)
Pesticide reduction	-0.022*** (0.003)	0.009 (0.013)	-0.053*** (0.005)	-0.042*** (0.005)	-0.002 (0.004)
Risk of spreading	-0.122 *** (0.021)	-0.394*** (0.109)	-0.189*** (0.037)	-0.209*** (0.035)	-0.19*** (0.033)
Theta					
Constant		0.590*** (0.175)	0.281 (0.226)	-0.422 (0.272)	-
Support		0.072 (0.169)	1.287*** (0.325)	1.353*** (0.336)	-
Risk		0.127 (0.148)	-0.612*** (0.229)	-0.392* (0.236)	-
Trust		0.062 (0.125)	0.244 (0.227)	0.348 (0.240)	-
Attitude towards progress		0.018 (0.107)	0.207 (0.227)	0.26 (0.238)	-
Attitude towards innovation		-0.276** (0.116)	-0.781*** (0.208)	-0.885*** (0.217)	-
Number of respondents	1396	522	418	211	245

*,**,*** presents significance at the 0.1, 0.05, 0.01 level., the standard error is written in parenthesis

The first class shows a significant negative attitude towards innovation. The second class is highly significant in the support of biotechnology combined with a negative value for the factor risk which means that possible risks of biotechnology are considered less problematic. Again, we find a highly significant negative attitude towards innovation. The third class shows the most negative attitude towards innovation but also the highest support of biotechnology. Risks are estimated below average. Respondents of the fourth class do not support biotechnology, perceive more risks and have less trust in institutions and scientists than respondents of the other classes. Contrary to this is their better more positive attitude towards innovation.

Table 9 shows the estimates of willingness to pay for the full sample and the four classes by attribute. Differences between the four segments are pronounced. Due to the positive parameter to price, mean willingness to pay across members in segment 1 and 4 are negative for some attributes. The price parameter of the first class is not significant what results in also insignificant WTP estimations.

Table 9: Willingness to pay Euro-Cent per 750g for GM French Fries by attributes

	Full Sample 1396	Class 1 522	Class 2 418	Class 3 211	Class 4 245
Fat reduction	-1.23 (-3.89;3.67)	-3.65 (-7.76;5.45)	0.16 (0.07;0.37)	1.15 (0.34;2.86)	-0.50 (-5.19;8.32)
Antibiotic antigen	24.23 (5.44;92.27)	9.36 (8.36;10.36)	7.27 (5.20;11.94)	44.08 (20.14;59.1)	67.74 (16.45;99.18)
Pesticide reduction	0.57 (-0.42;2.16)	0.25 (0.08;0.93)	0.51 (0.48;0.62)	1.95 (0.84;3.82)	0.16 (-3.86;7.17)
Reduction in risk of spreading	-17.26 (-52.44;42.47)	-51.14 (-110.64;78.73)	2.83 (1.75;5.85)	11.96 (4.18;28.94)	-4.52 (-55.74;85.8)

The 90-% confidence interval is written in parenthesis

WTP is largest for avoiding the risk of the antibiotics antigen. To avoid this risk respondents are willing to pay in average 24 Euro-Cent per risk percentage. This might be explained by the stronger dread of human health risks compared to environmental risks. Especially the fourth class reacts strongly on this risk with a WTP of almost 65 Cent while their WTP for the pesticide reduction is below average. Although this class has that positive attitude towards innovation we call these respondents “opponents of biotechnology”.

The second class has WTP estimates below the average. Respondents belonging to this class are more price sensitive than other respondents. They have a negative value in the factor risk which means that they perceive the possible risks to be less negative or dreadful than other consumers. This results in lower WTP to avoid health and environmentally risks. For this, we call these respondents “supporter of biotechnology”.

The third class is quite comparable to the second class with a less negative value on the factor risk. This might explain why WTP to avoid the mentioned risks is still high. Members of this class are less price sensitive than members of the second one. For this we describe these respondents as “general supporters” who perform a risk-benefit trade-off.

The first class can just be analyzed by their factor estimates because of the insignificant estimate for the attribute price. Due to their negative attitude towards innovation we call them skepticals of innovations.

Comparing WTP for French fries to WTP for paper reveals the WTP is less sensitive to possible risk of spreading or the benefit of pesticide reduction in the case of French fries. We observe for both products a smaller amount in WTP for possible benefits than for the reduction of possible risks.

We observed 47% of consumers who chose in all food choice sets option C the non GM alternative. In the case of paper, only 17% of respondents exhibited such strict behavior of refusing to buy GM products. It is questionable, if those choosing always option C are at all willing to trade off GM attributes and hence amenable to the multinomial choice framework.

We analyzed the sociodemographics for the found classes as well as their knowledge about biotechnology but did not identify any significant differences among the classes.

Conclusions

This paper presents preliminary results of consumers' willingness to pay estimation for a GM food and non-food product in Germany. Based on five factors describing consumer attitudes to gene technology, support, risk, trust, technical progress and technical innovation, we identify four different segments of consumers for both products. Respondents are more willing to pay for avoiding a risk than to get an additional benefit. The identified segments differ in particular in their willingness to trade off product attributes. This may hint to a deeply rooted resistance towards gene technology that precludes trading of risks and benefits in a utilitarian perspective. Further analysis of the data is required to investigate this issue in the future. The appropriateness of nested logit model or finite mixture model should be analyzed.

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Annex 1: Promax rotated factor loadings

Factors (error variance %)					
1 (58.4)	**2 (8.47)**	**3 (5.53)**	**4 (4.68)**	**5 (3.88)**	
.943	.179	.002	-.070	-.076	GM foods can cause an immense benefit for a lot of people.
.933	.203	-.147	.078	-.118	Using biotechnology the products can be produced in a way that is more friendly to the environment.
.906	.170	-.009	-.027	.054	GM foods might improve the standard of living of future generations.
.866	.150	-.035	.092	-.027	The use of biotechnology in food production might solve environmental problems.
.761	-.043	.001	.003	.241	GM foods are of higher quality than those produced without biotechnology.
.705	-.101	.031	.019	-.016	Risks related to biotechnology are acceptable.
-.487	.334	.026	.066	.048	GT foods are not necessary
.387	-.069	.324	-.053	.155	Environmental organisations overstate often and view dangers everywhere
.347	.927	.021	-.046	-.002	Even if a process is assumed to be safe it is not known what will be in 50 years.
.214	.811	.036	-.073	.125	GM foods might cause allergies.
-.123	.666	.088	.065	.041	Even if GM foods have benefits it is still unnatural.
-.283	.510	.029	.011	.218	GM foods are a danger for human health.
-.412	.479	.069	.075	.048	GM products always cause danger
.047	.418	-.077	-.177	.344	The use of biotechnology in food production might cause environmental risks.
-.125	.008	.905	-.055	.008	The food industry won't risk selling a harmful product because of fear of causing a scandal.
-.069	.056	.849	-.026	-.154	If scientists declare a product as safe I'll believe that.
.187	.360	.555	.155	-.222	GM products are more strictly controlled than those produced without biotechnology.
-.034	-.003	.011	.848	.118	Civilisations degree might be regognized by technical development.
.100	-.137	-.090	.774	.029	Due to technical progress it will be possible to solve future problems.
.053	.266	-.183	.126	.641	I don't trust new food products
.050	-.378	.320	.074	.575	Changes in nature due to humans rarely cause any serious problems.
-.084	.158	-.105	-.001	.544	Just big companies take advantages of biotechnology.