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DETERMINANTS OF FOOD RISK PERCEPTIONS - A MULTINOMIAL LOGIT MODEL

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1 Introduction

The 1990s were characterised by a large number of severe food safety crises. In response, consumers' perceptions of food safety and risks have changed. Large technical catastrophes were in the midst of attention after Seveso, Bhopal, and Chernobyl in the 1970s and 1980s, but with BSE and the advent of GM foods the risks of human technical advances upon nature have intruded our plates. To many it seems that the most human need of a safe food supply has become subject to the will of food engineers and profit-seeking enterprises.

Studies in the mid-nineties showed that the concern about food safety is particularly severe in Germany. Based on data from the Food Marketing Institute, von Alvensleben (1999) constructs an index of distrust in food safety and shows that Germany ranges at the top followed by Austria, Greece, the USA, and Norway. However, results of a series of consumer surveys shows that concern about food was highest during the second half of the 1980s and declined since then up to 1997 (VON ALVENSLEBEN, 1999).

Interested in the changing nature of risk perceptions related to foods, the German Federal Research Centre for Nutrition in Karlsruhe conducted a survey of about 2000-2500 households every year since 1992. We use these data to analyse the importance of different sensitivities towards technological, life style, and natural risks in determining how consumers evaluate risks related to food. The objective of this paper is to analyse how consumer perceptions of food safety risks have changed during the last decade. We focus on the importance of food safety risks in comparison to other environmental and technology risks and attempt the assessment of a multitude of specific food safety risks such as those related to genetic modification, food consumption habits, food pathogens, and residues. As European risk management and consumer policy build on the model of an educated and responsible consumer, we also focus on the role of knowledge about food risks in determining food risk perceptions.

The remainder of the paper is structured in four sections. First follows a brief review of the literature on food and health risk perceptions. The next section presents the data and methods used in the analysis. Finally, we present the results of our empirical investigation and conclude.

2 Food Risk Perceptions

The relationships between environmental/health and food risks are multidimensional and complex. Many factors, from individual risk perception to public discussion and political trends are changing according to internal and external dynamics in our societies. Starting with STARR'S (1969) analysis on revealed preferences, much attention has focused on the characterization of risk through psychonometric scaling and factor analysis. In his seminal work, SLOVIC analysed how attributes of risks influence risk perception (a concise summary of his work is provided in SLOVIC, 1987). SLOVIC has shown that people rank risks according to two

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factors: *dread risk* perceived by lack of control, uneven distribution in the population, and catastrophic or fatal consequences; and *unknown risk* characterized by lack of knowledge, of control, and of observability.

In later work, FLYNN et al. (1984) found that socioeconomic characteristics, voting behavior and the level of knowledge can influence an individuals' perception of health risks. DOSMAN et al. (2001) therefore argue that analyses of food safety related risk perceptions should follow a multivariate approach. They analyse the impact of socioeconomic determinants of health- and food safety related risk perceptions based on surveys in 1994 and 1995 of 959 and 953 Canadian households, respectively. They analyse risk perceptions related to bacteria in food, additives in food, and pesticides in food. They found that variables such as household income, number of children, gender, age, and voting preferences were strong predictors of an individual's risk perception. However, they also show that gender is the only variable that yields consistent results across all three classes of risks and across both years.

While our study is closely related to that of DOSMAN et al. (2001), it is also very different in several regards. Our data set allows us to cover the much longer time period from 1992 to 2002. Thus we can explore changes in the structure of risk perceptions over time. Secondly, we obtain less detailed data on the importance that individuals attribute to risks but we cover a broader and more detailed range of risks. In consequence, we construct a typology of consumers according to food risk perceptions. In addition, we describe individuals by their general perceptions of general environmental/health risks. We identify groups of consumers (1) not being concerned about any risks, (2) being concerned about all risks, (3) being concerned about risks from radioactivity and (4) being concerned about risks from radioactivity, cigarettes and job-related stress.

This *risk typology* of consumers appears highly relevant to our analysis because of arguments that can be found in the literature on environmental ethics. While standard neo-classical economic analysis suggests that the private ethical system of individuals is utilitarian, the environmental ethics literature argues that there is a broad ethical basis for human behaviour. MINTEER und MENNIG (1999) use a pragmatic approach to classify different environmental ethical systems by survey methods. GRIMSRUD and WANDSCHNEIDER (2003) use canonical correlation analysis to identify four ethical systems, of which two are more anthropocentric in nature and one is more spiritual. These analyses show that consideration of nature is formed within ethical systems that can differ among individuals.

One of the most important aspects of human nature is the need for food. The cultural value of food has long been recognized (see MURCOTT, 2003). Hence the individual approach to technology, life style, food, and risks related to these issues can be important in the explanation of the individual perceptions of food risks. We argue that not only the type of risk determines how consumers perceive risks, but also their own view and believe system of what type of risks is acceptable on a broader basis. Secondly we argue that knowledge about food safety risks can be important in determining the role attributed to different types of risks.

3 Data and Methods

We base our analysis on a data set covering annual cross-sections of about 1900 to 2400 consumers in Germany during the period from 1992 to 2002. Samples were drawn independently in every year, so that a panel structure cannot be established. In each survey consumers were asked about their assessment of alternative risks such as environmental risks, food risks, and behavioural risks. In a second section, respondents were prompted to indicate the importance they attribute to specific food risks such as pathogen contamination, residues, food consumption behaviour, alcohol consumption, genetic modification and biotechnology. In a third section, consumers were asked about their knowledge of several food safety risks and pathogens.

The survey was completed by a number of questions recording households' socio-demographic characteristics.

The survey design has changed several times over the years and therefore the datasets have been homogenized to assure consistency. Nevertheless, vital information was not collected in some years, so that we concentrate our analysis on the years 1992, 1995-1996, 1998 and 2000-2002. In November 2000, the first BSE case was detected in Germany. The subsequent series of BSE tests revealed a number of cases and triggered a crisis in the beef market. During 2001, it was quite interesting to observe how consumers' risk perceptions towards food changed and the survey was conducted twice. Thus, observations are available for April (2001-04) and November (2001-11).

In the survey, subjects could indicate on a binary scale if they consider a given risk as important or not. Despite the limitations of a binary scale, information is available for a large number of risks. We use this information to construct a consumer typology according to their risk perception.

3.1 Cluster Analysis of Households according to their Assessment of Environmental/ Health Risks and Food Risks

The data set contains information about the assessment of both environmental/health and food related risks. Regarding environmental/health risks ten assessments were asked: (1) radioactivity, (2) air, (3) traffic, (4) cigarettes, (5) water, (6) food & beverages, (7) noise, (8) climate, (9) job-related stress, and (10) drugs. Concerning the food-related risks the survey evaluated consistently twelve different risks: (1) moulds, (2) food additives, (3) spoiled foods, (4) pesticides and other residues, (5) growth hormones, (6) toxins, (7) alcohol, (8) unbalanced diet, (9) unprocessed foods, (10) cholesterol, (11) use of genetic modification, and of (12) biotechnology. Two of these were not asked consistently. For "unbalanced diet" the questionnaire talked about this risk only in early years but of "too much food" in later years. Similarly, sometimes the questionnaire asked about risks from "pesticides", in other years, the question referred to residues only in generic terms. We consider these two pairs as synonymous in the subsequent analysis.

To reveal clusters of risk assessment groups concerning environmental/health and food risk categories, respectively, the households were clustered according to the above mentioned ten and twelve assessment criteria. We carry out the cluster analysis with the data set jointly that means that we pooled all eight available datasets. The applied type of classification is the K-means-cluster-analysis and is appropriate for large data stets. It is similar to the hierarchic classification, but both the number of clusters and temporary cluster centres have to be fixed in advance. The final cluster centres are determined by an iterative procedure. The classification is done by the distances between single cases and the temporary cluster centres. The used distance measure is the Euclidean distance and the procedure of classification is the linkage between groups (see GODEHARDT, 1990).

3.2 Multinominal Logit Model

The cluster analysis groups consumers and their food risk perceptions into four different risk types. In a second step, we estimate a multinomial logit model to identify the determinants of this grouping. The multinomial logit model is appropriate to explain choices based on individual-specific (as opposed to choice-specific) data (GREENE, 2000: 875-879).

We label the clusters of consumers according to their *food risk* perception as $j = 0,1,2,3$. The multinomial logit model then estimates the probability of the observed cluster for individual *i* to belong to cluster *j* as

$$\Pr(Y_i = j) = \frac{e^{\beta_j' x_i}}{\sum_{j=0}^{3} e^{\beta_j' x_i}} \qquad j = 0,1,2,3 \tag{1}$$

The clusters are explained based on the individual-specific explanatory variables x_i for each cluster, so that a vector of estimated parameters results for each cluster $j = 0,1,2,3$. The estimation is done by maximization of the likelihood function.

The coefficients of the model are difficult to interpret. We thus report not only the estimated parameters but also the marginal effects of each explanatory variable that results as

$$\boldsymbol{\delta}_j = \partial \Pr_j / \partial \mathbf{x} = \Pr_j \left(\boldsymbol{\beta}_j - \overline{\boldsymbol{\beta}} \right) \tag{2}$$

where $\overline{\boldsymbol{\beta}} = \sum_{j=0}^{3} \Pr_j \boldsymbol{\beta}_j$. It is evident that neither the magnitude nor the sign of the marginal effects need to be equal to that of the estimated coefficients.

Table 1: Variable definition

Name	Definition
Explanatory Variables	
FEMALE	0 = male, 1 = female
AGE	Years
EAST	= 1 if household is located in former Eastern Germany, = 0 otherwise
CITYSZ	Household located in a city of ….. inhabitants: 1 = less than 4999; 2 = 5000-19999; 3 = 20000-49999; 4 = 50000-99999; 5 = 100000-499999; 6 = more than 500000
HHHEAD	=1 if respondent is household head, = 0 otherwise
HHKEEP	=1 if respondent is household keeper, = 0 otherwise
EDUC1	=1 if respondent has at least 10 years of school but not visited university, = 0 otherwise
EDUC2	=1 if respondent has visited university, = 0 otherwise
WORK	=1 if respondent works, = 0 otherwise
HHSIZE	Number of persons living in the household
KIDS	= 1 if children under the age of 14 are living in the household, 0 otherwise
INCOME	Monthly household net income in DM: 1 = less than 999, 2 = 1000-1249 , 3 = 1250-1499, 4 = 1500-1749, 5 = 1750-2000, 6 = 2000-2249, 7 = 2250-2499, 8 = 2500-2749, 9 = 2750-2999, 10 = 3000-3499, 11 = 3500-3999, 12 = 4000-4499, 13 = 4500-4999, 14 = 5000-5999, 15 = 6000-10000, 16 = more than 10000
C-R	=1 if respondent belongs to the cluster of consumers concerned only about risk from radioactivity, 0 otherwise
C-RCS	=1 if respondent belongs to the cluster of consumers concerned about risk from radioactivity, cigarettes and job-related stress, 0 otherwise
C-All	=1 if respondent belongs to the cluster of consumers concerned about all risks, = 0 otherwise
KNOW	% of food pathogens recognized.
Dependent Variable (Y)	
Y = No risks	Respondent is not concerned about any food-related risks
Y = Moulds	Respondent is concerned about moulds
Y = All but unprocessed	Respondent is concerned about all food-related risks but about unprocessed food
Y = Residues	Respondent is concerned about residues from pesticides and hormones in animal production

The explanatory variables considered in the model are listed and defined in Table 1: The sex of the respondent (FEMALE), her age (AGE), if the household is located in the former eastern Germany (EAST), the size of the city where the household is located (CITYSZ), the question if the respondent is the head of the household (HHHEAD) and if she participates in household keeping (HHKEEP), her educational attainment (EDUC1 and EDUC2), if she works (WORK), the size of the household (HHSIZE), if there are kids under the age of 14 living in the household (KIDS) and income (INCOME). We also include the risk type of the respondent revealed in a cluster analysis regarding environmental/health risks: The groups are concern about radioactivity (C-R), concern about radioactivity, cigarettes and stress (C-RCS), and concern about all types of risks (C-All). The baseline is the cluster of respondents not concerned about any type of risk.

Table 2: Summary statistics – variables at means[1]

	Total	**1992**	**1995**	**1996**	**1998**	**2000**	**2001-04**	**2001-11**	**2002**
Number of Observations	16781	2337	2435	1927	2141	2102	1932	1886	2021
FEMALE	0.546	0.499	0.536	0.539	0.544	0.568	0.567	0.549	0.579
AGE	44.92 (17.30)	42.58 (17.12)	45.46 (17.09)	44.99 (17.65)	43.33 (16.92)	45.65 (17.55)	46.27 (17.39)	46.20 (17.42)	45.32 (17.00)
EAST	0.199	0.181	0.207	0.203	0.183	0.194	0.218	0.185	0.221
CITYSZ	2.83 (1.84)	3.07 (1.91)	1.44 (1.11)	3.21 (1.81)	3.24 (1.79)	3.17 (1.79)	3.29 (1.83)	3.16 (1.82)	2.31 (1.74)
HHHEAD	0.641	0.599	0.658	0.633	0.690	0.595	0.653	0.645	0.658
HHKEEP	0.802	0.746	0.800	0.810	0.832	0.775	0.811	0.823	0.827
EDUC1	0.374	0.240	0.331	0.375	0.414	0.411	0.399	0.412	0.441
EDUC2	0.081	0.160	0.079	0.064	0.074	0.061	0.058	0.071	0.064
WORK	0.483	0.519	0.479	0.471	0.507	0.464	0.463	0.476	0.476
HHSIZE	2.37 (1.20)	2.44 (1.17)	2.34 (1.13)	2.38 (1.27)	2.36 (1.21)	2.39 (1.21)	2.36 (1.21)	2.34 (1.20)	2.31 (1.19)
KIDS	0.225	0.233	0.249	0.235	0.163	0.235	0.226	0.231	0.223
INCOME	9.40 (3.76)	9.07 (3.78)	9.13 (3.70)	9.11 (3.81)	9.45 (3.91)	9.59 (3.61)	9.84 (3.66)	10.08 (3.64)	9.05 (3.80)
KNOW	0.12 (0.12)	0.16 (0.13)	0.13 (0.13)	0.12 (0.12)	0.05 (0.07)	0.12 (0.13)	0.14 (0.13)	0.09 (0.09)	0.10 (0.10)
C-R	0.311	0.354	0.280	0.366	0.309	0.324	0.297	0.294	0.261
C-RCS	0.184	0.157	0.201	0.174	0.205	0.237	0.161	0.160	0.173
C-ALL	0.148	0.135	0.216	0.117	0.134	0.168	0.149	0.101	0.144

[1] For non-binary variables, standard deviations are reported in parentheses.

Finally, we include a variable that measures the respondent's knowledge about food related risks (KNOW). In the questionnaire, respondents could indicate the food pathogens they have heard about. Since the number and type of pathogens varied in each and every year, we constructed the variable KNOW as the part in total knowledge responses possible. Thus, a respondent could obtain a maximum score of 1, when she had heard about all pathogens and received a score of zero if she hadn't heard of any. Summary statistics over the eight yearly samples and the entire sample are provided in Table 2. The resulting construction of dependent variables and clusters used as explanatory variables will be explained in the results section, as they are constructed in the cluster analysis.

4 Results

4.1 Cluster Analysis of Households according to their Assessment of Environmental/ Health Risks and Food Risks

With respect to the environmental/ health classification the following four clusters resulted: For the first group of households the risk of radioactivity is most important (31.1 % of the sample are in this group), for the second radioactivity, cigarettes and stress (18.4 %), the third household group assesses no risk as important (35.7 %) and for the fourth household group all risks are important (14.8 %).

Concerning the food related risks another four groups are identified. The first household group assesses moulds as most important (34.9 %), the second group is not worried about any risks (30.1 %), the third group about all risks but from unprocessed foods (5.3 %), and the fourth household group assesses residues from pesticides and growth hormones as most important (29.7 %).

Table 3: Percentage of respondents concerned about different environmental/health risks in the four identified clusters[1]

	Cluster				Entire
	Radioactivity	**RCS**	**No risks**	**All risks**	**Sample**
Radioactivity	100.0 %	68.2 %	0.0 %	82.0 %	55.7 %
Air	30.8 %	18.9 %	32.1 %	89.0 %	37.7 %
Traffic	30.4 %	33.2 %	30.9 %	88.5 %	39.7 %
Cigarettes	34.5 %	60.0 %	27.5 %	76.6 %	42.9 %
Water	10.5 %	5.2 %	10.2 %	54.2 %	15.9 %
Food & beverages	27.3 %	19.7 %	30.1 %	74.3 %	33.8 %
Noise	14.2 %	33.9 %	12.6 %	74.9 %	26.2 %
Climate	32.0 %	25.6 %	27.0 %	83.9 %	36.7 %
Job related stress	0.0 %	100.0 %	14.1 %	66.5 %	33.3 %
Drugs	19.7 %	24.5 %	14.1 %	58.0 %	24.2 %
Total Cases	5213	3093	5997	2478	16781
% of Total Cases	31.1 %	18.4 %	35.7 %	14.8 %	100.0 %

[1] The percentage refers to the sample of 16 781 observations used in the multinomial logit analysis.

Tables 3 and 4 help in the interpretation of the formed clusters. In Table 3 the share of respondents being concerned about a particular environmental/health risk group is shown for each of the four clusters. It is apparent that German consumers are still highly concerned about radioactivity. 55.7 % of the total sample said to worry about this issue, which explains that radioactivity is such a dominant theme in the cluster analysis. Indeed, it appears in two of the identified clusters. As for the cluster not being concerned about any risk, Table 3 makes evident, that no particular issue is raised in a systematic manner. The same applies to the cluster of people concerned about all risks, where many of the risks are mentioned by more than 75 % of respondents in the group.

As to the partitioning of clusters regarding food risks, Table 4 shows the importance attributed by German consumers to residues from pesticides and others. Almost half of the sample considers this as an issue of concern. Maybe somewhat surprising is the fact that consumers seem to be almost equally concerned about moulds (39.6 %). But as made evident by the cluster analysis, the people concerned about moulds are different from those who worry about pesticides residues. In this first cluster “moulds”, people concerned about spoiled food are overrepresented in comparison to the entire dataset. It thus seems suitable to refer to this first cluster as the group of people being concerned about natural food risks.

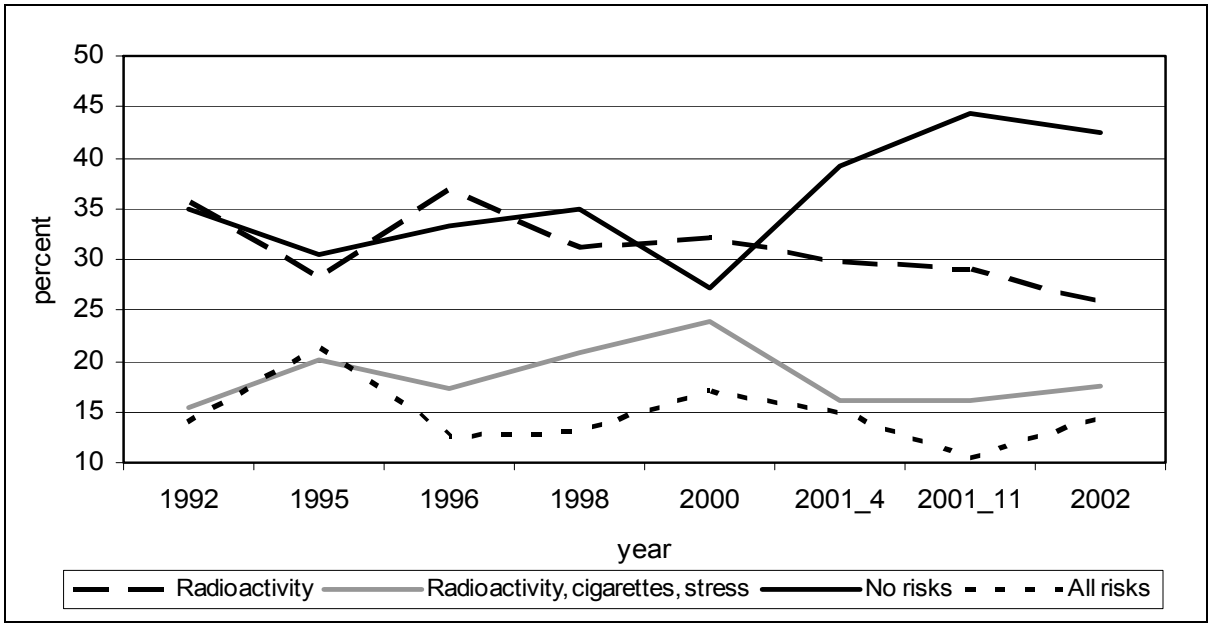
Table 4: Percentage of respondents concerned about different food risks in the four identified clusters[1]

	Moulds	No risks	All but unprocessed	Residues	Entire Sample
Moulds	100.0 %	0.0 %	87.4 %	0.3 %	39.6 %
Food additives	16.6 %	25.2 %	66.2 %	26.4 %	24.7 %
Spoiled foods	40.5 %	28.8 %	88.0 %	19.3 %	33.2 %
Pesticides	42.7 %	0.0 %	90.5 %	100.0 %	49.4 %
Growth hormones	26.6 %	35.0 %	87.3 %	50.2 %	39.1 %
Toxins	7.8 %	9.3 %	54.0 %	5.1 %	9.9 %
Alcohol	10.6 %	21.6 %	52.0 %	9.6 %	15.8 %
Unbalanced diet	8.1 %	21.0 %	55.8 %	11.7 %	15.5 %
Unprocessed foods	5.0 %	9.9 %	46.7 %	4.6 %	8.5 %
Cholesterol	9.3 %	18.2 %	65.5 %	9.2 %	14.9 %
Genetic modification	12.0 %	30.2 %	72.6 %	25.3 %	24.6 %
Biotechnology	3.6 %	13.2 %	55.2 %	7.5 %	10.4 %
Total Cases	5862	5051	882	4986	16781
% of Total Cases	34.9 %	30.1 %	5.3 %	29.7 %	100.0 %

[1] The percentage refers to the sample of 16 781 observations used in the multinomial logit analysis.

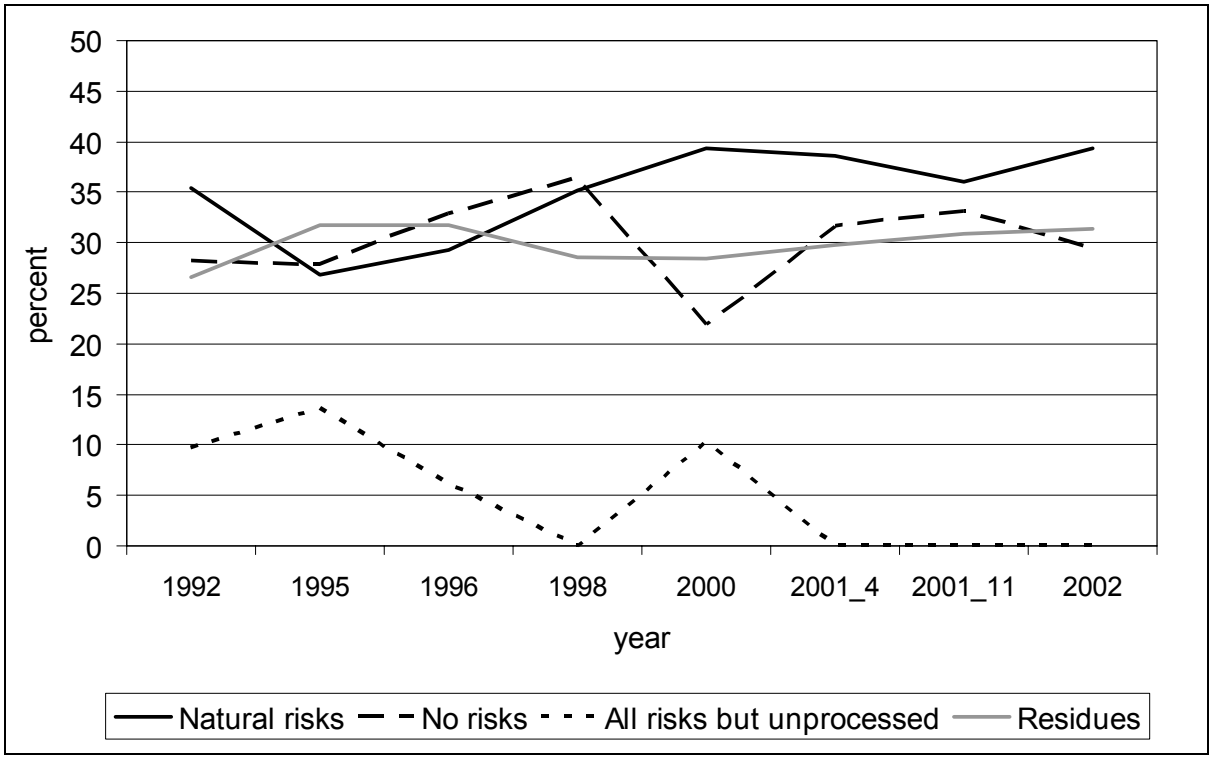
In the second cluster, consumers do not appear to be concerned about any risks in a systematic manner. In the third class all risks are ranked highly. Here we find also the people being concerned about the use of genetic modification and biotechnology. The fourth group is characterized by their concern about pesticide residues and hormone use with 100 % and 50 % respectively.

Figure 1: Share of households in different environmental/health risk groups from 1992 to 2002



Figures 1 and 2 show how the shares of households in different cluster groups changed over the period 1992–2002. With respect to the environmental/health risk groups it is obvious that the shares of households in each group do not change much over the years. Figure 1 indicates that the group "no risks" gains in importance and the group "all risks" declines. Also the worry about radioactivity decreases as time passes after the Chernobyl catastrophe of 1986.

Figure 2: Share of households in different food risk groups from 1992 to 2002



Regarding to the food related risk groups figure 2 shows that the importance of the group "all risks but unprocessed" decreases somewhat towards the end of the 1990s. Simultaneously the worry about "moulds" increases, while the importance of both groups "residues" and "no risks" fluctuates, but no significant trend can be discerned.

4.2 Multinomial Logit Model

The multinomial logit model correctly predicts 40.1 % of the observations. Since the parameter estimates cannot be interpreted directly, we present for brevity only the marginal effects in Table 5.

First we discuss the socio-demographic variables. Female respondents are less likely to be not concerned about any type of food risks and they are significantly more likely to belong to the cluster of consumers being concerned about moulds. Older people are also less likely to be not concerned about any type of food risks or to be concerned about residues, but they are more likely to be concerned about moulds. The same applies to households located in former Eastern Germany.

People living in larger cities are more likely to be concerned about residues from pesticides or hormones but are less likely to belong to the cluster of people being concerned about all types of food risks or moulds. The same applies to the person who is heading a household. Similarly, respondents being involved in household keeping are less likely to belong to the group of respondents who are concerned about moulds, and more likely to be concerned about residues. The literature on risk perceptions helps to explain this result. Being a household keeper, the respondent feels confident to be able to manage such an obvious risk as the development of moulds in food. On the other hand, residues are not detectable by the consumer herself, so she is more concerned about this type of risk.

Table 5: Marginal effects of explanatory variables on probability to belong to food risk perception cluster Y

	Y = No risks		Y = Moulds		Y = All but unprocessed		Y = Residues	
FEMALE	-0.0062		0.0229	**	-0.0031		-0.0136	
AGE	-0.0008	***	0.0017	***	0.0001		-0.0010	***
EAST	-0.0254	**	0.0631	***	0.0036	*	-0.0414	***
CITYSZ	0.0030		-0.0073	***	-0.0018	***	0.0060	***
HHHEAD	0.0094		-0.0254	**	-0.0068	***	0.0228	**
HHKEEP	-0.0056		-0.0190	*	0.0042		0.0203	*
EDUC1	-0.0027		-0.0253	***	-0.0009		0.0289	***
EDUC2	-0.0095		-0.0317	**	-0.0041		0.0453	***
WORK	0.0035		-0.0024		-0.0002		-0.0008	
HHSIZE	0.0006		0.0035		0.0011		-0.0052	
KIDS	-0.0262	**	0.0103		-0.0018		0.0176	
INCOME	-0.0005		-0.0036	**	-0.0007	**	0.0048	***
KNOW	-0.3081	***	0.1638	**	0.0730	***	0.0714	
KNOW × T	0.0328		-0.0126		0.0178	***	-0.0380	
KNOW × T^2	-0.0085	**	0.0047		-0.0010		0.0047	
C-R	-0.1336	***	0.1133	***	0.0114	***	0.0089	
C-RCS	-0.1332	***	0.1112	***	0.0225	***	-0.0004	
C-ALL	-0.1575	***	0.0876	***	0.0427	***	0.0271	**
T	0.0057		-0.0201	***	-0.0011		0.0155	**
T^2	-0.0003		0.0023	***	-0.0006	***	-0.0014	**

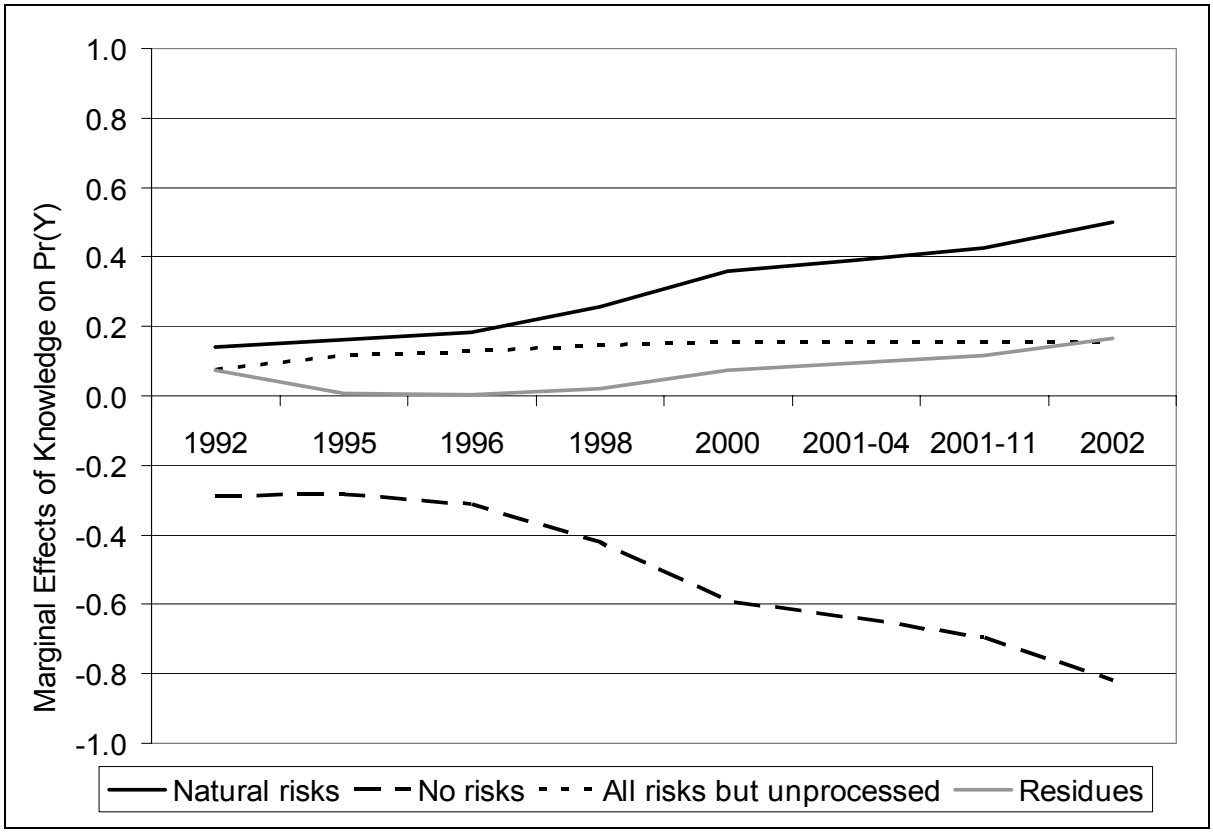
*, **, and *** refer to significance at the 0.1, 0.05 and 0.01 level, respectively.

Higher education levels make it less likely to be concerned about moulds and more likely to be concerned about residues. The variables work-force participation and household size are not significant. The fact that kids under the age of 14 years are present in the household makes it less likely that the respondent is not concerned about any type of food risk. However, it does not raise the probability to belong to any of the other three specific clusters. Higher income makes it less likely to belong to the cluster "moulds" or to those who worry about all sorts of food risks. However, they are more likely to be concerned about residues.

Increasing knowledge about food safety risks decreases the likelihood to belong to the cluster of respondents who are not concerned about any food risks. It increases the likelihood to belong to the group of those who are concerned about moulds or about all risks but those from unprocessed foods. These results suggest that the causality between these variables is not very clear. While more knowledge seems to make people more worried, it may also be the worried people who seek more information and who are thus better informed.

In the estimation we have interacted the knowledge variable with a time trend. It turns out the change in this relationship over time is very important. To illustrate the effect over time, we present it graphically in figure 3. Looking at the overall effect of knowledge over time, we see that the food safety crises over the last years have had their effects. Those respondents who know many of the pathogens are more likely to belong to the clusters of "worried about food" people. Good news seems to be that they are more likely to worry about food risks that experts consider of actual "risk nature", such as moulds, and less about risks that are by and most under control such as those from residues. Although moulds are in many cases no life-threatening risk, it is likely that our cluster analysis identified this cluster as the group of people who are concerned about natural food risks from spoilage and pathogens. The result is also in so far not surprising as most risk specific knowledge questions prompted respondents to indicate if, or not, they had heard about specific food pathogens.

Figure 3: Change in the probability to belong to the clusters Y in dependence of knowledge variable over time



Looking now at the clustering of respondents according to the general risk typology, we first note that the left out dummy is that accounting for the cluster of respondents who are not concerned about any of those risks. Belonging to any other cluster lowers the probability of belonging to the cluster of consumers who are not concerned about any type of food risks. It raises in particular the probability of being concerned about moulds or all types of food risks (but unprocessed) and being worried about all environmental/health risks makes it more likely to be worried about residues in food.

Looking at the marginal effects across clusters, it becomes evident that older respondents located in former Eastern Germany with high education levels, no kids and high knowledge about food safety risks are less likely to belong to the group of respondents who are not concerned about any food safety risks. In particular the fact to be worried about all types of environmental/health risks makes them less likely to belong to this group.

The cluster of people concerned about moulds counts likely more females than males and rather older than younger people. People in bigger cities and those involved in housekeeping and with higher income are less likely to belong to this group. As to the environmental/health risk clusters, belonging to any of the groups but being concerned about nothing also raises the probability to be concerned about moulds. Regarding the cluster being worried about all food risks, results are pretty similar. Obviously those concerned about all types of environmental/-health risks have a larger probability to be also concerned about all types of food risks. The cluster of people being concerned about food risks from residues is somewhat different. Being younger, coming from larger cities in the old federal states and heading the household with a higher income makes it more likely to be worried about these types of risks. However, controlling for all these variables, the likelihood of being in this cluster has decreased over time.

5 Conclusions

In this paper we have analysed food risk perceptions using eight large cross sections of German consumers covering the eleven-year period from 1992 to 2002. According to our results from cluster analysis, respondents are grouped into four clusters according to their food risk perceptions. Furthermore, we describe consumers by clusters based on their general risk attitude variables relating to radioactivity – a noncontrollable risk, risks from radioactivity, cigarettes and job related stress – risks typical for modern society, and finally those who are concerned about all sorts of risks. Respondents belonging to the cluster "radioactivity", that is those concerned about the noncontrollable risk, are more likely to belong to the cluster being concerned about moulds. The probability of being in the cluster "all but unprocessed" is in particular increased by being concerned about all environmental/health risks (C-all). Any of these concerns have only a small marginal impact of being in the cluster being concerned about residues. These results illustrate that a general risk typology of consumers can be of importance in understanding consumers' perceptions of special food risks.

Over time the share of consumers being concerned about all types of environmental/health risks has declined, this is even more the case for the cluster of people being concerned about all food risks. It seems that people have become more discerning in the risks that they are concerned about. This is supported by the fact that the knowledge variable plays a significant role in the explanation of the clusters and that its role has shifted over time. However, we also realize that the cluster of people not being worried about any environmental/health risks has increased over time. In conclusion, although food safety experts may be happy to learn that more consumers recognize the risks of natural food hazards, e.g. moulds, the number of consumers being concerned about residues from pesticides or hormones remains fairly stable.

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