No. 66

Extending the Application of Experimental Methods in Economic Analysis of Food-Safety Issues: A Pilot Study on the Impact of Supply Side Characteristics on Consumer Response to a Food Scare*, **

by

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June 2002

* The research project on which this paper is based, was partly funded by the "Nachwuchswissenschaftlerförderung der Justus-Liebig-Universität Giessen," the support fund for young researchers at the University of Giessen. The author is grateful for that and appreciates the support, without which the study would not have been possible. The author is also indebted to Philipp Hammer from the Federal Dairy Research Institute in Kiel and Silke Albrecht. Dr. Hammer was so kind to provide essential scientific information about the listeria hazard in dairy products. Silke Albrecht was effective and thorough in helping to prepare and conduct the experimental study. Without her, the experiment would not have run so smoothly.

** A revised version of this discussion paper has now been published in the European Review of Agricultural Economics.

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Abstract

Political and business decision makers need to understand the determinants of consumer response to food safety incidents for designing communication strategies that deal adequately with consumer concerns. In this paper supplier differentiation with respect to reliability as a theoretically derived determinant is put to a first empirical test in an experimental study. The results indicate that the existence of such a differentiation leads to a more pronounced negative response. But the total effect is ambiguous, as an increasing discrepancy in the reliability of suppliers was found to reduce the intensity of consumer response, thus contradicting the theoretical predictions.

1 Introduction

European consumers' concern about food-safety issues has risen considerably in the past decades. The continuing BSE crisis has greatly contributed to this development most recently. But less prominent food scares more restricted in duration or impact are also important to both consumer concerns and industry performance. Examples are dioxin in pork, illegal use of growth promoters in calf fattening, or outbreaks of infectious diseases through food-borne pathogens, such as salmonella, listeria or E. coli bacteria.

Such food scares have become a major cost factor for the food industry worldwide. Costs are either caused by quality-assurance efforts for prevention or by product failure. Product-failure costs comprise of a number of cost categories, e.g. failure analysis, liability, product recall, extra promotion, and foregone sales due to consumer response. It is this latter component of food-safety related cost that is especially troublesome for manufacturers and retailers, as consumer response can be very drastic and in combination with a damaged image can threaten the company's existence. Hence, for suppliers the knowledge of determinants of consumer response to a food scare is of key importance.

In a recent article, Böcker and Hanf (2000) have proposed an expected-utility model in which the impact of a food scare on a consumer's trust in a supplier is determined by the perceived discrepancy between the reliability of different suppliers. A key finding of the model analysis is that the loss of trust after a food scare increases with

this discrepancy. If this was to be observed in reality, serious implications for a company's or a sector's quality and information strategy with respect to food safety issues would result.

With this paper I present an attempt to test this theoretical model empirically through an experiment conducted in December 2000, for which listeriosis in specialty cheese was chosen as a particular risk factor. The primary objective of the study is to establish whether differences in the reliability of supplier types have the predicted effect on consumer response. Provided that is so, one secondary objective is to establish how relevant supplier differentiation is for consumer response relative to demographic and experience related factors. The other secondary objective is to introduce a rather simple approach to better assessing the external validity of an experiment that primarily investigates a hypothetical situation.

The rest of the paper is organised as follows. The next section first gives an overview of food safety related economic research and positions experimental studies therein. Then the model with its key findings is presented. Section three describes the experimental design. The fourth section presents and discusses the results of the experimental study. Eventually, section 5 summarises the main findings and concludes the paper with an outlook on future research.

2 Economic analyses of food-safety issues

In the past two decades, a growing number of economic analyses of food-safety issues have been published. The body of literature is diverse and covers various specific research questions. This section tries to give a brief overview of this research, including the role played by experimental studies. The basis for expanding the experimental research agenda is developed in more detail in the final subsection which describes the model underlying this study.

2.1 Overview of research areas

Two distinct strands can be distinguished in the literature on economic analyses of food safety-issues. The first is concerned with external shocks to the food system and studies the impact of single events or a series of events on consumer behaviour. Analyses of particular food scare incidents that received considerable public attention, like

the 1982 heptachlor milk contamination on Hawaii (Smith et al., 1984; Liu et al. 1998), the Alar controversy in the US in the late 1980's and early 1990's (Ravenswaay and Hoehn, 1991; Herrmann et al., 1997) and the BSE crisis since the mid 1980's in the EU (Burton and Young, 1996, 1997; Verbeke et al., 2000) belong to that strand. In these studies the external event is typically modelled through the (accumulated) number of media reports containing health risk related information as an explanatory variable in a demand equation or system. Consumer response is typically analysed at an aggregate level of demand for homogeneous goods. Exceptions are Herrmann et al. (1997) and Verbeke et al. (2000) who include demographic characteristics for a more differentiated picture of the determinants of consumer behaviour vis-à-vis a food scare. Differentiation of the supply side, e.g. with respect to origins, marketing channels, or supplier types, however, has not been considered as a determinant of consumer response yet.

The second and much larger strand in the economic literature on food safety deals with cost-benefit analyses of private or public measures for improvements in food safety. Obviously, this strand can be split further in a branch that primarily deals with the cost of implementing such measures, and one that primarily tries to put a value, in terms of benefits, on safer food.

The first branch analyses the process and cost of compliance with new regulation (French and Neighbors, 1991; Henson and Heasman, 1998) or cost related impacts of implementing quality-management systems, such as HACCP (Nganje, 1999) or ISO 9000 (Zaibet and Bredahl, 1997), or safety-enhancing technologies (Jensen et al. 1998). Major difficulties for producing reliable cost estimates are the definition of relevant cost in the first place and uncertainty of firm response and strategies under different food-safety-regulation scenarios, as discussed in MacDonald and Crutchfield (1996), Caswell (1998), and Loader and Hobbs (1999).

The research in the second branch is motivated by the fact that the benefit to be measured is hardly directly valued in markets[1] (Caswell, 1998, p. 411). Two different approaches for generating the necessary information can be identified. The first employs

[1] The main barrier to using market evidence is that of availability of data. While appropriate techniques, like the hedonic price analysis, that has already been widely applied in studies of the value of nutritional or health characteristics of food products, are available, data on a product's safety are not (Caswell, 1998). But as more data become available with the increase of food products marketed with food safety characteristics, such analyses will become more and more feasible, as for those goods, for which safety attributes are available in the product description, as e.g. cars (Boulding and Purhit, 1996).

proxy measures of the cost of food safety incidents to estimate the cost that could be avoided through enhanced food safety. The *cost-of-illness* measure is most widely used and long established, e.g. in the US for cost-benefit analyses of food safety regulation (Roberts, 1985). It primarily aggregates costs caused by medical treatment and productivity or income losses. It is criticised, however, for not incorporating costs of averting behaviour, subjective or relatively intangible cost elements, such as fear, pain and suffering, and being rather sensitive to the assumed value of a saved life[2]. This measure's appeal, however, is that it denotes the lower bound of possible benefits of specific regulatory elements in a fairly reliable way. A complementary proxy measure that could provide information about the subjective elements are *liability costs*. But here, data availability is extremely constrained, as only a diminishing share of all cases are taken to court and often settled out of court, where compensation payments are not disclosed (Buzby and Frenzen, 1999).

The second approach is targeted at preference elicitation, where three different methods are applied to capture intangible individually perceived costs through estimating consumers' willingness to pay (WTP) for increased food safety. The results of conjoint analyses, contingent valuations and experimental markets have, however, not played a role in formal cost-benefit analyses for food safety regulation yet (Caswell, 1998).

While *conjoint analysis* has been widely applied in food-marketing research to elicit consumer preferences for new products, its application to food-safety issues is rather new. The earliest such references found in a literature search[3] are Baker and Crosbie (1993) and Halbrendt et al. (1994), with applications to apples and pork respectively. This method is most attractive when consumers can be presented with a number of product choices that are precisely defined by salient product attributes and immediately deliverable, because then the choice process is rather close to that in actual markets. Therefore, Caswell (1998, 415) considers conjoint analysis more popular in new product testing than in cost-benefit analyses for political decision making.

Contingent valuation typically presents respondents with two products, a stand-

[2] For a discussion of the problems associated with determining the "correct" value of a (statistical) life, see Golan and Kuchler, 1999.

[3] For the search the ECONLIT database from 1969 onwards was utilised, using as search terms "conjoint" combined with "food", "safety", or "acceptance". In total, only five references with a conjoint analysis application to food safety were found.

ard one and one with improved safety attributes, for which the WTP can then be elicited in different ways. Generally widely applied in the assessment of public goods, it is the one of the three methods that has also been used most often for elicitation of food-safety preferences[4]. This is primarily due to its flexibility – it can be conducted in mail and phone surveys and personal interviews – and little resource demand compared to the other two. While the insights in consumer preferences and their determinants gained through contingent valuation studies are most valuable, there remain various points of criticism that have prevented it from having been accepted for political and legal decision making (Cummings and Glenn, 1994; Belzer and Theroux, 1995, Covey et al., 1998). The most severe arguments focus on conveying and controlling the relevant information about a hypothetical situation and the likely lack of incentives to seriously evaluate food safety, mainly because of the absent budget constraint as a determinant of subjects' responses[5] (Fox et al., 1995; Caswell, 1998).

As both an alternative and complement to the survey based contingent valuation methodology, the *experimental-market approach* to the analysis of food safety has been developed in the past decade. In the beginning, experimental markets were mainly seen as an independent valuation procedure that was able to overcome the shortcomings of a hypothetical situation with no real budget constraint by simulating real-world decisions in a laboratory environment[6] (Shin, 1991, 8). The advantages over contingent valuation are threefold (Buzby et al., 1998). First, revelation of true preferences is encouraged through an adequate auction type, i.e. the Vickrey second-price, sealed bid auction, and the requirement to consume the product that is bought in the auction. Second, participants are forced to consider their budget constraints, as their final payment depends on their buying or bidding behaviour. And third, possible response and sample biases can be limited through an adequate recruitment procedure. Sources of risk that have been investigated are diverse and range from pathogen reduction (Shin, 1991; Hayes et al., 1995; Fox et al., 1998, Buzby et al., 1998) via bST in milk (Fox et al., 1995) to sewage

[4] The same database search as for conjoint analysis, for which "conjoint" was replaced with "contingent" yielded 15 contingent valuation studies in the area of food safety, with the first reference in 1986.

[5] A further fundamental critique concerns the fact that the WTP for increased safety is usually elicited directly. Carthy et al. (1998) and Beattie et al. (1998) provide empirical evidence that direct or one-step elicitation captures the wealth/risk of death trade-off inappropriately. Instead they suggest a multi-stage approach to break this trade-off down in conceptually manageable steps.

[6] Shin (1991) was the earliest of eight references found in a literature search on the ECONLIT database who applied experimental markets to the elicitation of food safety preferences.

sludge (Stenger, 2000) and alternative safety assurances for seafood (Wessells and Anderson, 1995). With the exception of production techniques, i.e. integrated pest management or organic vs. conventional produce (Huang, 1996; Govindasamy and Italia, 1998; Thompson and Kidwell, 1998), however, differentiation with respect to supplier types has not been investigated yet either.

Due to enhanced control of focus variables and more differentiated data-recording possibilities, the application of experimental methods has been gradually extended from that of an isolated elicitation procedure to a tool for improving validity and reliability of contingent valuation. Fox et al. (1995, 115 ff.) distinguish two areas of application with respect to timing. Ex ante, as an additional part of thorough pretesting, experiments are used to choose and refine the most appropriate elicitation technique for a planned survey. Ex post, experimental-market trials can be applied in a hybrid procedure termed CVX-M by Shogren (1993) to calibrate WTP measures obtained through contingent-valuation surveys, thus providing a cost-effective tool for increasing the validity and accuracy of surveys. Fox et al. (1998), in the first application of CVM-X to food safety, report calibration factors between 0.28 and 0.83, depending on context and product. That means that WTP figures from the contingent-valuation survey were between 1.2 and 3.6 times those from the experimental studies, which clearly supports the conjecture that a non-existent budget constraint leads to exaggerated WTP statements. Other studies, however, do not report such large discrepancies between the two elicitation methods (Shogren et al., 1999).

The scope of nonmarket valuation in laboratory environments can be further extended to include tests for systematic biases in experimental markets that have been noted by Shogren et al. (2000) in case of exaggerated bids for unfamiliar goods. They come to the conclusion that this is primarily due to preference learning, as the bid is increased to entail the value of information about a new and unfamiliar good. Experiments can thus be utilised to test for fundamental assumptions and principles of economic theory (Kahneman et al., 1990).

2.2 Introducing supplier differentiation as a determinant of consumer response

The previous section has given a brief overview of the research in the area of food safety. In these studies it is standard to assume that consumers use aggregate information on hazard probability directly in their purchase decisions. I put forward three

arguments that it is justified to assume that, instead, consumers refer likelihood judgments to the reliability of different types of suppliers. First, applying the attribute categories introduced by Nelson (1970) and Darby and Karni (1973), food safety is essentially an experience attribute, sometimes even a credence characteristic (Caswell and Mojduszka, 1996). Because of this imperfect information trust is an important element in the consumer's choice of a particular supplier or retailer. News about a food scare, in which a so far preferred supplier is involved, may make a consumer revise his prior beliefs about, i.e. his trust in this supplier. This might then influence his purchase decision, while he does not consider the overall probability of being harmed.

Second, consumers usually do not have available aggregate figures about product failures or food-poisoning incidents. Information relating to non-statistical indicators, e.g. of attitude and behaviour of suppliers, thus becomes more valuable for risk assessment. Major advantages of such indicators are that they are easier to understand than likelihood figures and that they help to identify the most promising alternatives for directed search.

Third, with respect to food safety in particular, there is empirical evidence that consumers differentiate amongst brands, retailers or product origins with respect to reliability. In a survey of German consumers, Becker et al. (1996) found that "trust/safety" was the fourth most important reason to choose a particular retailer for meat products. A more general differentiation between countries of origin with respect to trust is also reported by Haase (1998).

In the following subsections a model proposed by Böcker and Hanf (2000) is briefly described in which differentiation between suppliers with respect to reliability is introduced as a determinant of consumer response to a food scare within an expected-utility framework.

Model assumptions

First, assume consumer K divides the universe of suppliers of a certain good X in two groups. Group B is perceived to be less reliable than A. Thus, K judges the probability $P(H|A)$ of purchasing a hazardous unit X^H from type A suppliers to be smaller than the respective probability $P(H|B)$ assigned to B. K always purchases from supplier J, which he believes to be of type A. But since K is not perfectly informed, his trust in J to be reliable is represented by the probability P_J, leaving a probability of 1- P_J for J be-

longing to group *B*. The probability P_H to purchase an unsafe unit from *J* is:

(1) $$P_H = P_J P(H|A) + (1 - P_J) P(H|B)$$

Now assume *K's* state-dependent preferences are represented by an expected-utility function with his health state after consuming a unit of the good *X* or the substitute *Y* as an argument. *K* is aware of potential health problems associated with the consumption of *X*, e.g. listeria bacteria in cheese. He will only buy *X*, if its expected utility is greater than that of *Y*, where such a hazard does not exist or he is simply not aware of it:

(2) $U_X^+ (1 - P_H) + U_X^- P_H > U_Y$, where:

U_X^+: utility from a normal, i.e. safe unit of *X*,

U_X^-: utility from a hazardous unit X^H,

U_Y: utility from a unit of *Y*; with $U_X^- < U_Y < U_X^+$,

P_H: probability to purchase an unsafe unit from *J*.

Consuming a hazardous unit of *X* will yield a very low utility, close to or equal zero. Compared to that level, the "normal" utilities from *X* or *Y*, are very high, although they only relate to a marginal decision. Replacing P_H with (1) and rearranging (2) yields:

(3) $$\frac{U_X^+ - U_Y}{P_H} > U_X^+ - U_X^-$$

The right hand side of the inequality will be rather large, while the numerator on the left hand side will be very small. For *X* to be bought at all, P_H must be very small. And as can be seen from **(1)**, P_H decreases, as P_J increases. Trust in supplier *J* has thus an impact on the purchase decision via determining P_H.

Previous studies by Hakes and Viscusi (1997), Eom (1994) and Liu et al. (1998) have underscored the importance of the dynamic aspects of risk perception and the usefulness of Bayesian models as an optimising framework for economic analysis. So as a final assumption, after receiving negative information about the safety of product *X* sold by *J*, *K* revises his prior belief about the reliability of *J* according to Bayes' Rule.

Consumer response: impact of a food scare on trust

Assume *K* receives news about a food scare, in which *J* has been involved. He revises his trust in *J* according to Bayes' Rule so that the posterior probability P_{PJ} results. This is the conditional probability of the state "*J* is of type *A*." after having observed the event "*X* sold by *J* is unsafe.":

$$\textbf{(4)} \qquad P_{PJ} = \frac{P_J P(H|A)}{P_J P(H|A) + (1 - P_J) P(H|B)} = \frac{P_J}{P_J + v(1 - P_J)}$$

$$\text{with: } v = P(H|B) / P(H|A);\ v > 1, \text{ as } P(H|B) > P(H|A).$$

The level of trust after the food scare depends on the prior level of trust P_J and the perceived discrepancy between the reliability of different supplier types, as captured by the ratio *v*. As can be seen from (4), the ex post level of trust decreases with this discrepancy. Defining *D* as the decline in trust, $D = P_J - P_{PJ}$, consumer response to a food scare thus becomes more drastic, as *v* increases. Hence, the linkage between this discrepancy and the loss of trust due to a food scare will be investigated.

3 The experiment

The study was conducted as a pencil-and-paper experiment in five sessions with 20 subjects each on December 13th and 15th, 2000. Venue was the main seminar room in the 'arsenal' building of Giessen University. The room proved to be well suited for the experiment for two reasons. First, it was big enough for seating the subjects sufficiently far apart, so that leakage of information and interaction between subjects could be reduced to a minimum (Friedman and Sunder, 1994, 63). Second, it was still small enough to create an intense working atmosphere. In the following three subsections I

first present the rationale for choosing a particular – and rather little known – risk factor and then the experimental design. Finally, the structure of an experimental session is described, as the central experiment needed some preparatory phases.

3.1 Choosing a particular risk factor: listeria bacteria in specialty cheese

A major task in setting up the experiment is to create an environment, in which information about a food scare is perceived to be credible and realistic without creating a feeling of actual threat in any of the subjects. Therefore, the choice of an appropriate product and risk factor is crucial for attracting subjects' attention and evoking their interest in the topic. Specialty cheese and listeria bacteria were chosen for the following reasons. First, specialty cheese with its great variety in types and production methods is a rather exclusive product[7], for which the difference between raw and pasteurised milk is important both for product quality and potential hazard by listeria bacteria. Its being rather novel to most participants lead to the conclusion that it would catch subjects' attention more easily than a more common product.

Second, for increasing the sense of reality, the experimental input should not be restricted to information but should also include a product trial. Cheese has the great advantage that it is easy to serve.

Third, listeriosis is rather rare and has received little public attention yet in Germany. Therefore, it was quite likely that this hazard would be novel to most participants, thus increasing interest in the topic, while keeping the effect of prior knowledge as a nuisance variable low. Also, as major outbreaks have not occurred in Germany yet, the hazard is "distant" or unlikely enough not to create a feeling of actual threat in the product and market trial phase. The information provided to the subjects is similar to but more detailed than the description of listeriosis presented in Figure 1.

[7] Prices for specialty cheese range from about DEM 25 to DEM 60 per kg, as opposed to the more common cheese types, the bulk of which is sold at prices in the range from DEM 7 to DEM 25.

Figure 1: Characteristics of listeriosis

Occurrence of pathogens
Listeria bacteria are ubiquitous, as they can be found in soil, nearly all foods and living animals. There have also been reported cases of Listeria having become in-house bacteria in slaughter-houses and dairies. With respect to cheese, various studies report contamination rates for raw milk cheese to be 5 to 15 times higher than those of cheese made of pasteurised milk. Among the numerous varieties, *L. monocytogenes* is mainly responsible for human illness.
Infection, disease and vulnerable groups
L. monocytogenes causes serious illness in humans. Infection can occur through skin contact, intake of contaminated food (primary source of infection) or for the unborn through mother blood. It mainly affects the pregnant uterus, the central nervous system and the blood stream. The severity of the disease ranges from skin irritation to flu-like illness, vomiting and diarrhoea and to meningitis, foetal death, stillbirth and death. The incidence of human listeriosis is low (2-15 cases per million inhabitants), but case fatality rate is high, with figures being reported around 30%. Vulnerable groups are pregnant women, their unborn children, little children, the elderly and immunocompromised people, e.g. HIV positive or those who received a transplant recently.
Major outbreaks due to contaminated food items
21 outbreaks reported, varying in their impact between 4 and 750 cases, with a maximum of 85 deaths (France 1992). Of the 21 outbreaks, 7 were caused by dairy products, 6 by meat products, 4 by fish and also 4 by cereals and vegetables.

Source: Information taken from various parts of EC (1999), Loncarevic et al. (1995), and Eppert et al. (1995).

3.2 Experimental design: treatment levels and measurement of trust

The experimental design follows straight from the theoretical model proposed by Böcker and Hanf (2000). The experiment is intended for a test of the auxiliary assumption that consumers differentiate between types of suppliers with respect to reliability. The focus variables to be controlled directly correspond to the model variables $P(H|A)$ and $P(H|B)$. Two different levels are assigned to $P(H|A)$ and $P(H|B)$ each. As the extent of loss in confidence due to a food scare is determined by the ratio of $P(H|B)$ to $P(H|A)$, v, the ultimate goal of controlling $P(H|B)$ and $P(H|A)$ is to create different levels of v.

For invoking the perception of distinct types of suppliers that differ in reliability, information about a hypothetical trade association of specialty-cheese importers was given to the subjects in the form of a newspaper article. The majority of this association's member firms were certified for "outstanding quality," with the actual certification procedure being delegated to independent third-party authorities. The share of listeria-contaminated samples in a quality-control study served as indicator of reliability. The two different levels for $P(H|A)$ (certified member firms of the trade association) are

0.302% and 0.110%, those for *P(H|B)* (specialty cheese retailers that are not members of the trade association) are 1.857% and 0.459%.[8] The different levels of *v* resulting from this variation are shown in Figure 2.

Figure 2: Levels of reliability ratio *v* resulting from combinations of subjective probabilities *P(H|A)* and *P(H|B)*

	P(H|B)	
P(H|A)	0.459%	1.857%
0.110%	III) $v = 4.2$	IV) $v = 16.9$
0.302%	II) $v = 1.5$	I) $v = 6.1$ *

** Replaced by control group.*

The information was presented to the subjects of the corresponding treatments as part of a newsletter to the association's member firms, e.g. for situation II:

> *... results have been confirmed for listeria. The incidence of L. monocytogenes in the samples is as follows:*
>
> *Certified member firms: 0.302%*
> *Non member firms: 0.459%*
>
> *We see these results as reconfirming our efforts in quality assurance and hope that the Certificate of Outstanding Quality will prove to be a competitive advantage for members of our association. As a matter of fact, the incidence of Listeria monocytogenes has been about one and half (four, seventeen) times higher for non member firms than for certified member firms.*

Since situations I) and III) do not differ very much, I) is replaced by a control group, for which no difference between supplier types with respect to reliability is reported. Instead, the newsletter describes a situation in which the hygiene performance had improved in the entire industry in the past years:

[8] These figures appear to be very high, but they were deliberately chosen to be below those of actual quality control studies, e.g. Eppert et al. (1995) or Loncarevic et al. (1995). These studies also give a more differentiated picture with respect to the level of contamination, which is central to the likelihood of an outbreak. To avoid information overload of the subjects, this aspect was omitted and generally lower contamination levels chosen instead.

... results have been confirmed for listeria. The incidence of L. monocytogenes in the samples has been found to have decreased in the past four years:

1996:	*0.712%*
2000:	*0.475%*

We see these results as reconfirming our efforts in quality assurance and hope that this development will prove to be a competitive advantage for specialty cheese retailers. As a matter of fact, the incidence of Listeria monocytogenes has been cut by nearly a third in that period.

Since no difference is made between supplier types, $v = 1$ is assumed for I) so that in total four different treatment levels of the focus variable v result.

Information about the particular retailer, who was to be involved in a food scare, was provided to the subjects in a format resembling newspaper articles. In all treatment levels the firm was described as traditional, family run and with a strong quality and safety orientation. Distinctions between group I) on the one hand and groups II) to IV) on the other had to be made with respect to the certification. In I) he was described as a a member of the trade association, while in the remaining groups he was described as being amongst the first member firms to have been certified. In order to broaden subjects' information basis for evaluating the retailer, results of a customer survey that was described as having been conducted by a market-research company on behalf of the retailer were presented to the subjects. The share of positive responses to three questions concerning a) friendliness and service of personnel, b) competence and knowledge of personnel, and c) credibility of owner manager with respect to consumer protection were reported. The figures ranged from 70% to 99% in order to create the impression of a reliable retailer and were completely randomised.

In the process of designing the experiment, it became evident that it would be impossible to induce subjects into trusting a hypothetical retailer. The creation of trust in a buyer-seller relationship is a complex and time consuming process (Halk 1992). Furthermore, in everyday language trust is often perceived to be an either/or option and not a continuous concept. Therefore, the trust variables P_J and P_{PJ} and thus the response to a food scare are measured through the proxy variable RELIEF. It is based on the two emotional dimensions regret and relief[9], which can also be interpreted as affective components of the attitude toward the retailer. These two emotions are closely linked with

[9] Two further variables were used for describing subjects' emotional response to that hypothetical situation. But as they capture the more general concept of 'concern' that has been applied in various studies at a rather general level (Alvensleben 1998, Bergmann, 1997), they are not included in this analysis which focuses on the most direct response affecting a particular supplier.

directly evaluating the outcome of a concrete action or decision. Especially for regret this has been confirmed by Zeelenberg et al. (1998) in a series of experiments. To create a hypothetical action whose outcome had to be evaluated by the subjects, they were asked to imagine a situation, as described in Figure 3.

Figure 3: Scale for proxy variable of subjects' trust in retailer

Please, imagine you have been invited to a dinner party, where also a selection of cheeses is being offered at the buffet. After having tried various cheeses, you learn that all the cheese has been supplied by the retailer RHO. How would you describe your feelings after that information? For answering this question, please use the scale provided below. The endpoints of the scale, 0 and 100, are described in brief. Please, choose a number between 0 and 100 that corresponds with your feelings between the extreme points, and then fill in that number down in the box on the right.			
			Points
0 points I would **regret** very much to have eaten the cheese.	_____	100 points I would feel great **relief** to know this particular retailer had supplied the cheese.	

Subjects had to perform this evaluation twice: before and after they received information about the retailer's involvement in a food scare. This information was also presented to the subjects in a format resembling newspaper reports. A link to trust can be made by interpreting an increasing intensity of negative feelings, i.e. getting closer to the left on the scale, as an indicator of decreasing trust in the retailer.

3.3 Structure of experimental session

In total, an experimental session lasted 1 hour and 35 minutes and was divided in five phases (s. Figure 4). After the general introduction, phases two and three are intended to create the necessary interest and the feeling that the risk factor is a realistic one. As a by-product, these phases, as well as the final phase, produced additional data on socio-demographic and risk-perception variables. Phase four is the actual test of the theoretical model. Finally, phase five measures changes in hazard-related judgements caused by the provided information, and elicits subjects' impressions for validation purposes.

Figure 4: The five phases of an experimental session

A: General introduction (Duration: 10 minutes)
Subjects are welcomed and rules of behaviour explained to them. Subjects are informed about the general procedure in the product and market trials and that the final payment varies from DM 40 to DM 43, depending on purchase decisions in that phase.
B: Questionnaire survey (Duration : 20 minutes)
Socio-demographic variables, purchase and consumption behaviour with respect to cheese. Judgement variables concerning four specific risk factors associated with food products: listeria bacteria, salmonella bacteria, genetically modified organisms and BSE.
C: Product and market trials (Duration : 30 minutes)
Round 1: Information about listeria bacteria and listeriosis; more specifically about listeria in milk and dairy products, differentiating between raw and pasteurised milk. Product trial: subjects are asked to try two types of hard cheese and to rate their taste. ***Round 2:*** Information about major outbreaks of listeriosis in past 15 years, indicating the number of people being infected and killed, and about the most recent product recalls in Germany (in these cases nobody was harmed). Market trial: both types of cheese and option to renounce offered at different prices. ***Round 3:*** Information about regulation for cheese manufacturers and exporters and about hard cheeses, to which the two types offered belong. Market trial: under the same conditions as in round 2.
D: Experiment for actual test of theoretical model (Duration: 25 minutes)
Round 4: Information about a specialty-cheese trade association and one particular retailer. Trust measurement: subjects indicate how they would feel, if they had tried some cheese and learned afterwards that the cheese had been supplied by the particular retailer. ***Round 5:*** Information about a food scare for which the particular retailer is responsible. Trust measurement: the same as in round 4.
E: Questionnaire survey (Duration: 10 minutes)
Same knowledge and judgement variables as in opening survey, but concerning only listeriosis. Questions about subjects' impression and evaluation of the experiment.

4 Results

4.1 Overview: sample characteristics and responses

100 subjects participated in the experiment, 42 male and 58 female. The great majority (94) were students. The average age was 24, ranging from 19 to 44. With respect to study areas, food-science and home-economics students had the largest share (21), economics the second largest (13), pedagogics the third (11), agriculture and medicine with 10 each the fourth. 38 of the subject live in a single household, again 38 in two or three person households, while 20 live in households of four or more. Participation in household shopping is large, as 59 stated to mainly do the shopping themselves and a further 35 to do it together with someone else.

Most subjects consume cheese frequently: 29 daily, 61 several times a week and only 10 once a week or less. Asked how many varieties they typically eat during a week, 17 stated one, 35 two, 29 three and 11 four or more. 17 subjects stated that they deliberately buy raw-milk cheese.

An individual characteristic that is of great interest here, is a subject's personal experience with food poisoning incidents, because a negative experience – either personally or concerning close friends or relatives – can be assumed to have an impact on consumers' safety preferences (Henson, 1996; Buzby et al., 1998). 25 subjects stated that they had experienced a food poisoning before, while 22 reported such an incident for a close friend or a family member. As there was some overlap, in total there were 41 subjects who had been affected by a food poisoning – either directly or indirectly.

4.2 Impact of supplier differentiation with respect to reliability

The first step in testing the theoretical model is to look for differences between the four treatments with respect to the dependent variable. Corresponding with the model terms P_J and P_{PJ} for trust before and after the food scare, these variables are named P_{J_RELIEF} and P_{PJ_RELIEF} respectively. The descriptive statistics are shown in Figure 5, which also includes the response indicator D defined as $D = P_J - P_{PJ}$. The results can be summarised as follows:

- the figures are significantly lower after the food scare than before for all treatment levels, while – with the exception of IV) – standard deviations increase,
- the P_J mean of the 'control' treatment level I) is the lowest, while its PP_J mean is the largest; consequently, response of group I), as measured by *D_RELIEF*, is the least drastic of all treatment levels,
- opposite of the model prediction, *D_RELIEF* is not maximised under treatment level IV) ($v = 17$), but instead under treatment level III) ($v = 4$).

Figure 5: Descriptive statistics for dependent variable RELIEF

		Total sample	I) *v=1*	II) *v=1.5*	III) *v=4*	IV) *v=17*
	N*	96	25	25	23	23
P_J_RELIEF	Mean	.727	.708	.708	.737	.759
	σ	*.171*	*.180*	*.150*	*.169*	*.191*
P_{PJ}_RELIEF	Mean	.432	.468	.401	.401	.459
	σ	*.196*	*.219*	*.192*	*.194*	*.179*
D_RELIEF	Mean	.295	.240	.307	.336	.300
	σ	*.239*	*.225*	*.217*	*.277*	*.242*

** For the analysis only those cases were considered that a) were complete for a proxy variable, i.e. in both rounds there had to be a response, and b) were consistent with theory, i.e. the figure stated in round 4 had to be above that stated in round 5. Because of these requirements, responses from 4 subjects were omitted.*

For testing whether differences in consumer response, as captured by *D_RELIEF*, are related to the treatment levels, three orthogonal contrasts, i.e. mutually nonredundant comparisons of means are chosen. From *p* treatment levels *p-1* orthogonal contrasts can be created (Kirk, 1995, p. 115) so that any further contrast can be expressed as a linear combination of the orthogonal contrasts. With the three contrasts, the following questions shall be answered:

Q1: Is there a significant difference between consumer response under treatment level I) (no differentiation) and the average response under treatment levels II), III) and IV)?

Q2: Is there a significant difference in consumer response between the treatment levels II), III) and IV) with an explicitly expressed degree of differentiation with respect to reliability?

For answering these questions, three hypotheses that express orthogonal contrasts can be derived, where $\overline{D_i}$ stands for the *D_RELIEF* means of the various treatment levels:

$H\text{-}0_{Q1}$: $\overline{D_I} = \frac{1}{3}\overline{D_{II}} + \frac{1}{3}\overline{D_{III}} + \frac{1}{3}\overline{D_{IV}}$ and $H\text{-}A_{Q1}$: $\overline{D_I} < \frac{1}{3}\overline{D_{II}} + \frac{1}{3}\overline{D_{III}} + \frac{1}{3}\overline{D_{IV}}$

$H\text{-}0_{Q2a}$: $\overline{D_{II}} = \frac{1}{2}\overline{D_{III}} + \frac{1}{2}\overline{D_{IV}}$ and $H\text{-}A_{Q2a}$: $\overline{D_{II}} < \frac{1}{2}\overline{D_{III}} + \frac{1}{2}\overline{D_{IV}}$

$H\text{-}0_{Q2b}$: $\overline{D_{III}} = \overline{D_{IV}}$ and $H\text{-}A_{Q2b}$: $\overline{D_{III}} < \overline{D_{IV}}$

For testing these hypotheses both a t-Test and the nonparametric Mann-Whitney U-Test were applied, because the normality assumption appeared violated for the dependent variable, but the requirement of equal variances not. But as the test statistics in Figure 6 show, the results are fairly robust over the tests employed.

Figure 6: Test statistics for three orthogonal contrasts*

Contrasts		t-Test				Mann-Whitney U-Test			
		Means		t-	Signi-	Mean Ranks			Signi-
A	B	A	B	value	ficance	A	B	Z	ficance
$\overline{D_I}$	$\left(\overline{D_{II}} + \overline{D_{III}} + \overline{D_{IV}}\right)/3$	.314	.240	1.34	.092	41.2	51.1	-1.54	.063
$\overline{D_{II}}$	$\left(\overline{D_{III}} + \overline{D_{IV}}\right)/2$	.307	.318	0.18	.430	36.0	36.0	-0.01	.495
$\overline{D_{III}}$	$\overline{D_{IV}}$	.336	.300	0.46	.325	24.4	22.7	-0.43	.334

**The significance figures are for a one-tailed test.*

Concerning the statistical significance of differences between means, the null could not be rejected in any of the six cases, if the convention of $\alpha = 0.05$ were being followed. But in a pilot study of this kind the type II error has to be considered more closely in order to assess the likelihood of not rejecting a false H0 hypothesis and thus discontinuing a promising line of research (Kirk, 1995, p. 62). In order to meet the additional restriction of a minimum power of a test, $\alpha = 0.10$ was chosen as an acceptable significance level for rejecting the null for each contrast[10]. Consequently, the $H0_{Q1}$ hypothesis that there is no difference in consumer response between treatment level I) and the average of treatment levels II), III), and IV), has to be rejected. Differences among treatment levels II), III), and IV), are, however, not significant, so that hypotheses $H0_{Q2a}$ and $H0_{Q2b}$ cannot be rejected.

The final question to be asked is that of practical relevance of the statistically significant contrast expressed by $H0_{Q1}$. For answering this question the relative measure of effect size is applied (Cohen, 1988, p. 20 ff.), which is defined as absolute mean dif-

[10] For $\alpha = 0.10$ and a standardised difference between means of 0.1 considered to be relevant, the power of the t-tests ranges from 0.69 to 0.84 so that the convention of an acceptable level of power between 0.70 (Sachs, 1999, p. 197 f.) and 0.80 (Kirk, 1995, p. 60) is satisfied.

ference divided by the square root of the error variance. As the data here fit a completely randomised ANOVA design, the within-group mean square over all treatment levels from a one factorial ANOVA is an adequate estimator of the error variance (Kirk, 1995, p. 129). The effect size for *D_RELIEF* is 0.309 $\left(= 0.07443/\sqrt{0.05788}\right)$. As Cohen (1988) considers effect sizes of 0.2 (0.5) to be small (medium), the effect has to be considered as of relatively little practical significance.

Interpreting these results, one can conclude that supplier differentiation moderately intensifies consumer reaction relative to a situation with no differentiation. The extent of differentiation, as expressed in failure probabilities, however, does not have an additional impact on consumer response.

4.3 Socio-demographic and experience variables

The next step of analysis will turn to the possible factors outside the theoretical model that might influence subjects' responses. Although assignment of subjects to the treatment levels was completely randomised, the four groups' composition with respect to extraneous sources of variation might differ. As the experimental control of these sources of variation was not possible or feasible, their effects can be controlled for in a regression analysis. When selecting such covariates, one has to be aware that the additional variables must either be measured prior to the treatments' presentation or coming in effect or be independent from the treatments (Kirk, 1995, p. 710).

In the basic regression model consumer response is determined by the level of trust prior to the food scare, P_J, and the reliability ratio v. Furthermore, the dummy variable k is introduced, which differentiates between treatment level I) (1) on the one hand and levels II), III), and IV) on the other (0). This is done to utilise the results of the above comparison of means and to capture the differences in content and style of the information provided to the two groups. Thus, the basic model is:

$$\textbf{(5)} \qquad D = \alpha + \beta_1 P_J + \beta_2 v + \beta_3 k + \mu$$

From the results of the previous t-Test and also in line with theoretical predictions, β_3 is expected to be negative. The theoretical model predicts opposite signs for β_1 and β_2: D increases both with P_J and v.

Appropriate sources of extraneous variation are socio-demographic and experience factors, because they meet the requirement of being independent from the treatment levels and can be expected to influence consumers' safety preferences and response. Here, two variables are introduced in the regression analysis. Possible gender related differences in risk perception are taken into account with the dummy variable SEX (0 for male, 1 for female). POIS, also a dummy variable, differentiates between subjects who have been affected by food poisoning (1), either directly or indirectly as discussed above, and those who have not (0)[11]. The regression model in (5) thus extends to:

$$\textbf{(6)} \qquad D = \alpha + \beta_1 P_J + \beta_2 v + \beta_3 k + \beta_4 SEX + \beta_5 POIS + \mu \,,$$

Concerning empirical evidence on the influence of gender on consumer response to a food scare, analyses of the general concepts of consumer concern (Bergmann, 1997, p. 125) or mistrust (Halk, 1992, p. 147) did not reveal significant differences. The analysis of consumer response to the Alar crisis by Herrmann et al. (1997, p. 518) showed that women tend to react, i.e. reduce consumption, more often than men. This is supported by Henson (1996), whose contingent valuation survey revealed a higher WTP for risk reduction for women than for men. Due to lack of opposite evidence, I expect the sign of the β_4 coefficient to be positive. Although one would expect people with a food poisoning experience to react more drastically than those without, empirical evidence on that linkage, however, is ambivalent. While Lin and Milon (1995) found that the experience of having been sick from eating unsafe oysters increased the WTP for a risk reduction significantly, Henson (1996) found the opposite in his consumer survey on chicken and eggs. Therefore, no a priori statement about the expected sign of β_5 is made, so that a test of its significance is two-tailed. The regression results for (5) and (6) are shown in Figure 7.

[11] Age as another socio-demographic factor that could influence risk perception and consumer reaction (Halk, 1992, p. 147; Herrmann et al., 1997, p. 518) was considered, too. But due to the sample age structure – 73% of the subjects were between 19 and 25 years old – regression analyses did not show any explanatory power. Instead, regression performance, as measured by the corrected R^2 and the F-statistics, was reduced considerably. Therefore, it is not included in the analysis.

Figure 7: Regression results for base and extended model

Model	Constant [a]	P_J [b]	v [b]	k [b]	SEX [b]	POIS [a]	R^2 [corrected]	F-statistics
Base	-.268	.824	-.003	-.072			.359	17.16
	(.004)	*(.000)*	*(.195)*	*(.079)*			[.338]	*(.000)*
Beta coefficient		*.589*	*-.081*	*-.132*				
Extended	-.357	.822	-.005	-.063	.099	.106	.436	13.59
	(.000)	*(.000)*	*(.077)*	*(.101)*	*(.007)*	*(.010)*	[.404]	*(.000)*
Beta coefficient		*.587*	*-.130*	*-.114*	*.205*	*.218*		

[a] *Error probabilities , which are given in parentheses, are for a two-tailed test.*
[b] *Error probabilities , which are given in parentheses, are for a one-tailed test.*

The independent variables have been subjected to a multicollinearity diagnosis in the SPSS regression-analysis procedure. All indicators[12] were far from suggesting a noteworthy degree of collinearity between any of the variables. Furthermore, in both regression analyses the distributions of residuals were not found to deviate considerably and systematically from a normal distribution.

For both models, the regression model is highly significant, as the F-statistics indicate. Comparing beta coefficients and significance levels between independent variables, consumer response is mainly determined by the prior level of the trust proxy variable P_J*_RELIEF* in both models. The direction of the impact is as predicted. The base model basically replicates the results of the previous analysis in that k is found to have a significant but moderate impact, while v remains insignificant.

By introducing SEX and POIS, however, this changes quite a bit. First, the impact of v becomes significant, and its relevance, as expressed by the beta coefficient, is considerably increased, while k loses in relevance and significance. But the impact of v is opposite to the direction predicted by the model analysis. Such an ambivalence in the impact of the expressed discrepancy between supplier types might point to a specific feature of subjects' risk perception that extreme discrepancies are not perceived to be credible and thus have a lesser impact than medium but more realistic or credible levels of discrepancy.

[12] Correlation between regression coefficients was at most 0.42 for k and v, while remaining in a very moderate range of absolute values between 0.02 and 0.16 for the remaining variable pairs. Consequently, the composed indicator 'tolerance,' which would have to be below 0.1 to indicate collinearity (Brosius and Brosius, 1996, p. 495), was always greater than 0.785 for any independent variable.

But relative to the newly introduced variables SEX and POIS, the market related variables *v* and *k* remain of fairly little relevance. First, SEX and POIS increase the corrected R^2 considerably, and their regression coefficients are significant at the 0.01 level. Second, their beta coefficients point to an impact that is approximately twice the size of *v* and *k*. The regression coefficients indicate an increase in the response, or loss of trust, by roughly 10 percentage points when switching from men to women or from participants without to those with a food-poisoning experience.

4.4 Further analysis of factors affecting validity

One focal point of criticism concerning experiments in economics is the external validity of the experimental results. It has been questioned that they can generalise to comparable situations in actual decision making (Caswell, 1998). This point cannot be neglected for this particular experiment, because subjects were asked to respond to a food scare in a hypothetical situation, and was therefore accounted for in two ways. First, as pointed out above, specific care was given to the phases preceding and preparing the central experiment in order to create the necessary sense of realism. Second, the degree to which subjects perceive the information about the risk factor and the food scare as realistic can be observed in order to identify the impact of a possible failure to create the required sense of realism.

This observation was obtained in the final questionnaire from subjects' level of agreement with the statement *"The information appeared to have been completely made up."* which they were asked to report on a five point scale with endpoints "I totally disagree." (1) and "I totally agree." (5). With responses ranging from 1 to 4 and a mean of 1.48 performance of the experiment with respect to achieving an authentic atmosphere has to be judged as good. For analysing the impact of the individual judgements more closely, they are introduced via the variable *MADE_UP* in the regression analysis, so that model (6) extends to:

$$\textbf{(7)} \qquad D = \alpha + \beta_1 P_J + \beta_2 v + \beta_3 k + \beta_4 SEX + \beta_5 POIS + \beta_6 MADE\_UP + \mu \,,$$

There is no a-priori information about the expected sign of the regression coeffi-

cient, so a two-tail t-test will be applied. Regression results[13] are reported in Figure 8.

Figure 8: Regression results with additional validation variable

Model	Constant [a]	P_J [b]	v [b]	k [b]	SEX [b]	POIS [a]	MADE_UP [a]	R^2 [corr.]	F-statistics
Base	-.331	.834	-.003	-.072			.036	.372	13.47
	(.001)	*(.000)*	*(.218)*	*(.077)*			*(.171)*	[.344]	*(.000)*
Beta coeff.		*.597*	*-.073*	*-.133*			*.115*		
Extended	-.481	.830	-.005	-.066	.115	.128	.071	.479	13.34
	(.000)	*(.000)*	*(.069)*	*(.082)*	*(.002)*	*(.002)*	*(.008)*	[.443]	*(.000)*
Beta coeff.		*.592*	*-.131*	*-.121*	*.238*	*.263*	*.216*		

[a] *Error probabilities , which are given in parentheses, are for a two-tailed test.*
[b] *Error probabilities , which are given in parentheses, are for a one-tailed test.*

Introducing *MADE_UP* in the base model does not have a considerable impact. The test statistics of P_J, v, and k are hardly changed, and the validation variable itself is insignificant. This changes, however, in the extended model. First, introducing *MADE_UP* increases the fit of the model considerably. Second, the significance levels of all variables are improved. And third, the magnitude of the impact of the variables SEX and POIS is increased considerably.

Overall, these results point to a rather robust model structure. The improvement by the additional variable points further to the advantage or almost requirement of including socio-demographic and individual variables, such as SEX or POIS, in the analysis of food-safety-related preferences, as has been remarked by Eom (1994, p. 767).

Furthermore, the effect of *MADE_UP* itself is highly significant, at the 1% level. Its impact, as measured by the beta coefficient, is only slightly below those of the variables SEX and POIS. The positive sign of the regression coefficient suggests that, as subjects judge the information provided as less realistic, i.e. tend to agree more with the statement *"The information appeared to have been completely made up."*, their response to the food scare becomes more drastic. Assuming that lower levels of perceived authenticity lead to lower levels of subjects' activation, this effect could be termed 'reduced activation bias.' To my knowledge, neither for experimental nor for contingent-

[13] Subjecting *MADE_UP* to a multicollinearity diagnosis did not reveal a noteworthy degree of collinearity between it and any of the other variables.

valuation studies in the area of food safety, implementation of such a "validation device" has been reported yet. This clearly calls for taking such phenomena into consideration and investigating them more deeply in future research in order to take account of subject-related biases.

5 Summary and discussion

This study presents an extension of experimental analyses in the area of food safety, which so far have mainly dealt with the elicitation of preferences for specific risk reductions. Theoretical predictions concerning the impact of supplier differentiation with respect to reliability on consumer response to a food scare have been put to an empirical test in an experimental study. In addition to the supply-side-related factors outlined in the theoretical model, the impact of three more variables is analysed: gender, experience with a food poisoning, and the subjects' impression of the authenticity of the provided information.

Empirical support for the theoretical prediction that an increase in the discrepancy between suppliers' reliability intensifies consumer response is mixed. On the one hand, in those cases, in which a discrepancy in supplier reliability was explicitly expressed and stressed in the information provided to the subjects, the intensity of consumer response is significantly larger than in the situation without apparent differentiation between supplier types. But on the other hand, an increasing level of discrepancy – opposite to the theoretical predictions – was found to decrease the extent of consumer response. However, the first finding concerning the comparison between situations with and without differentiation should serve as a hint to food suppliers not to attempt to openly differentiate on the basis of food safety characteristics to gain competitive advantage. The argument against such discriminating behaviour is that in case of a food safety incident, consumer response will likely be intensified.

Two further individual factors, gender and food poisoning experience, are found to play a significant role in explaining the intensity of consumer response. First, women react more drastically than men. Second, subjects with a food-poisoning experience also react more drastically than those without. The impact of these variables is considerably larger than that of the supply-side-related information. Introducing a variable intended for facilitating external validation improved the performance of the regression analysis considerably. The variable captures the subjects' impression of the authenticity of the

provided information. It is found that those who rated the information as less realistic, tended to react more drastically, indicating a need to adjust the reported consumer response downward when generalising to real world situations.

But also some potential shortcomings of the analysis need to be discussed. First, only the immediate response to a food scare was reported, which might tend to overstate consumer reaction. But assuming that a sharp decline in trust due to a food scare is more difficult to recover than a less pronounced one, the immediate response is a good indicator of the effort necessary for restoring consumer trust.

Second, the sample is surely not representative of the population in Germany. For testing the model implications, however, this was not necessary. But as the analysis has revealed a significant impact of socio-demographic and individual factors, future research in that area should be based on more representative samples.

And third, the experimenter's goal not to create a feeling of actual threat by the information provided is put to a test by asking subjects to state their level of agreement with the statement: *"The information did not worry me at any time."* 55 subjects agreed or totally agreed with that, 23 were indifferent, while 22 disagreed or totally disagreed. A share of 22% who were worried by the information to a considerable degree points to a dilemma in the experimental analysis of food-safety issues. On the one hand realistic and concrete information is necessary for realistic and non-casual responses. On the other hand, such information causes worry and might lead to adverse reaction by the subjects, the worst of all possible outcomes. This dilemma will be apparent in all attempts to inform consumers about food-safety issues: any information will worry a considerable share of consumers and might lead to reversed effects, i.e. avoidance of such troubling information.

Finally, a pilot study like this calls for an outlook on future research. First, the ambiguous results concerning the impact of supplier differentiation need to be addressed. Promising avenues are to check whether format and content of the information provided are adequate with respect to risk perception processes, or whether the experimental design needs to be changed. In particular, more basic research is needed about the extent to which consumers actually differentiate between suppliers with respect to reliability, and about cues and information sources consumers utilise for that purpose. Second and concluding, introducing an internal 'validation variable' by asking subjects as to how realistic the provided information was perceived, points to a promising route

for better assessing the external validity of an experiment that requires subjects to imagine their reaction or behaviour in a hypothetical setting. The improvements achieved in this study by utilising the responses to one rather simple question should encourage extension and refinement of adequate validation devices.

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