

**Consumers between indifference and mistrust:  
French and German behaviour regarding the potential introduction of nanotechnologies in food**

*Technological innovations in the agri-food sector raise the issue of their acceptability by consumers and their market entry in Europe. Recent research on perceptions of nanotechnology in food enables to understand and anticipate potential consumer reactions before the introduction of new products. One survey highlights indifference among German and French consumers as regards nanotechnologies, as well as a form of pessimism towards these products. An experimental economics study carried out in a laboratory shows a mistrustful attitude from French and German consumers and a low acceptance for nano-food or food nano-packaging. In the present state of knowledge and taking into account consumer attitudes towards this technology, possibilities for developing nano-products in the agri-food sector currently appear to be limited.*

The design and transformation of products on the nanometric scale, that is to say at atom level, are called nanotechnologies. This technological innovation allows products to be improved and will probably be a great source of progress. However, it raises a lot of questions and concerns, so much so that a national debate on nanotechnologies involving scientists and members of civil society was organized in France between October 19<sup>th</sup> 2009 and February 24<sup>th</sup> 2010 (CNDP 2010 National Commission on Public Debate). The agri-food sector is not without potential applications of nanotechnology in its manufacturing process, packaging or fortification of foodstuffs. For the moment, these applications are a matter of research and development and according to the European Commission, there was no nano-food sold in the European Union in 2011 under a label mentioning the use of nanotechnologies. Food industries would therefore seem to be very wary of consumers' reactions.

The perception of risk in food poses acute questions of corporate strategy and public intervention on the subject. The debate on GMO

(Genetically Modified Organisms) is a good illustration of consumer reluctance and hesitation, particularly in Europe, in the face of innovations in the food business. There are still a lot of questions around the development of nanotechnologies in this sector, as scientists remain cautious about their potential risks.

In such an uncertain context and in the absence of products processed by such technologies today, we endeavoured to analyse consumer behaviour facing various uncertainties in two socio-cultural contexts (France and Germany) and in focusing on nano-foods and food nano-packaging. In order to analyse both the role of information on decisions and the role of perception and attitude in the face of risks, we used two complementary methods from sociology and economics: survey and laboratory experiment (see: methodological frame). Surveys using questionnaires allow extensive recruitment of individuals, while laboratory experiments give better control over the information revealed to participants. The studies were carried on symmetrically in France and in Germany.

## Methodological frame

### 1. Complementary surveys by questionnaires and laboratory experiments

Two identical questionnaires were sent out via internet to France (752 participants) and Germany (750 participants), to a sample that was each representative of the population by sex, age, education and profession. In addition to the general questions about socio-demographic characteristics, respondents were asked more focused questions on their familiarity with nanotechnologies, religious beliefs, confidence in science and technology, and their perception of nano-food risks and benefits. Moreover, questionnaires included a general description of nanotechnologies and information on enriched nano-food and nano-packaging.

Simultaneously, two laboratory experiments were conducted in Munich (143 participants) and Paris (152 participants) with people selected by the method of quotas and representative of both cities as regards age and socio-economic status. These experiments checked the information revealed to participants very precisely. The participants' choices to buy or not to buy the products according to the price of the orange juice were hypothetical, meaning that participants did not take the orange juice away at the end of the experiment (which is usually the case in experiments with real products). After each round of information was revealed, participants would indicate whether they would buy the orange juice or not for a list of several prices in ascending order. Willingness-to-pay (WTP) was determined by the highest price for which a consumer accepted to buy the bottle of orange juice.

### 2. Information and experimental economics

The methods of value identification granted by consumers to merchantable or non-merchantable goods (such as environmental goods) involved questioning the agents directly about their willingness-to-pay in order to reduce health risk, or more generally to obtain a better-quality good. The *experimental economics* (including experiments *in the laboratory* or *in the field*) placed a group of agents in a position where their true behaviour was simulated (laboratory) or influenced (field test) in order to reveal their willingness-to-pay for the given qualities of a good. The advantages of the experimental methods lie in the payment of the good according to the selected values and in the precision of the checks on the information revealed to consumers, including an assessment of their initial knowledge through *ex ante* and *ex post* questionnaires.

When participants modify their willingness-to-pay in a statistically-significant way, experimental economics provides individual measures and an average willingness-to-pay for a special characteristic or more precise information. The variation in willingness-to-pay isolates the willingness-to-pay for the additional characteristic, independently from the initial allocation or from the original value of the product provided during the experiment.

Two (virtual) “objects” were studied: an orange juice enriched with vitamin D by nanotechnologies (nano-food) and an orange-juice bottle made using nanotechnologies to protect nutrients from ultraviolet rays (nano-packaging). Since these products are not available in stores, the characteristics of these “nano-juices” revealed to participants had to be made up from the present literature on food processes and these are therefore potential characteristics with regard to the existing scientific and technical literature.

### In France as in Germany, consumers do not have precise ideas on nano-foods

The answers to the surveys show that a large majority of French (81.5%) and German (66.4%) participants do not really know about nanotechnologies. At the beginning of the survey, they have no or little knowledge of nanotechnologies. In both countries, men and people with a higher education background are the most familiar with nanotechnologies.

With a model of multinomial logistic regression, we can link the participants' final opinions to a set of socio-demographic variables and initial

perceptions. After receiving the information concerning applications in the agro-food sector, the result is that the majority of agents have an “ambiguous” opinion towards nano-food and food nano-packaging. A lot of participants describe their opinion of nanotechnologies like being “neither positive, nor negative” and declare that they have no precise opinion of the risks and benefits of such applications. In other words, most of the population would seem to be rather indifferent to nanotechnologies.

The number of agents expressing a pessimistic feeling towards nanotechnologies is greater than those with an optimistic feeling. The latter are also the agents who, initially, had better knowledge of the subject. However, this result concerns only nano-packaging and the information provided had no effect (influence) on the participants' behaviour towards nano-food, in this case, nano-orange juice enriched with vitamin D. The most pessimistic agents towards nanotechnologies at the end of the survey are the ones who have a generally reluctant behaviour towards sciences and technologies (assessed through general questions at the very beginning of the survey).

Confidence in government agencies also has an impact on positive or negative feelings, while religious belief does not have impact much on attitudes towards nanotechnologies. Agents who are believers are more liable to form an opinion on nanotechnologies but that opinion does not induce any positive or negative differentiation towards nanotechnologies. Moreover, it appears that the belief-in-god effect on negative attitudes is partly lessened by the other “ethical” variables, in particular, “pro-scientific and pro-technological attitudes”.

These results, which apply both to Germany and France, clearly show that the participants’ general and initial perceptions of sciences and technologies influence their final opinion on nanotechnologies in a decisive way.

### **Information on nanotechnologies lessens consumer Willingness-To-Pay (WTP)**

Analysis of the impact of various types of information on willingness-to-pay (WTP) was carried out by laboratory experiments. At the beginning of the experiment, the product (orange juice) and its selling price were briefly presented without any mention of nanotechnologies. Next, simple wording was revealed to the participants indicating that nanotechnologies were used to enrich the orange juice with vitamin D or to manufacture the bottle to protect from UV. Finally, information was given in more detail by explaining the supposed impact of nanotechnologies on health, environment or society (including firms’ monopolistic power and patent rights). Between three types of messages, participants choose the one they wish to receive. Due to scientific uncertainty, detailed messages contained both positive and negative information linked to an accurate scientific review.

The average participants’ WTP for orange juice after each round of information revelation is reported in figure 1. The result is that the information revealed on the use and supposed consequences of nanotechnologies significantly modifies consumers’ WTP, including when the information given is simple and short and is limited to the mere disclosure of nanotechnology use to manufacture the orange juice or its packaging. A simple piece of information leads to a significant fall in WTP (variation between the second and first line), except for use of nano-packaging in Germany. So, even in the absence

of information on the potential risks linked to that technology, a significant number of participants express reservations towards nanotechnologies by lowering their WTP. This innovation is immediately seen in a negative light despite offering advantages such as enrichment with vitamins or protective packaging. This result must be compared with the results of the surveys on internet showing that participants’ general and initial perception of sciences and technologies influences their final opinion on nanotechnologies decisively.

Giving more detailed information amplifies the fall in WTP. Information about health appears to have high priority in consumers’ eyes, since more than 80% of the participants recall that aspect for the choice of the detailed message. It leads to a significant fall in participants’ WTP: the part of the message mentioning a benefit has been totally eclipsed by the information on the potential risks. More detailed information does not modify the reservations previously expressed when the simple piece of information mentioned the presence of nanotechnologies. The information about society and the environment chosen by the rest of the participants does not influence the participants’ WTP as much.

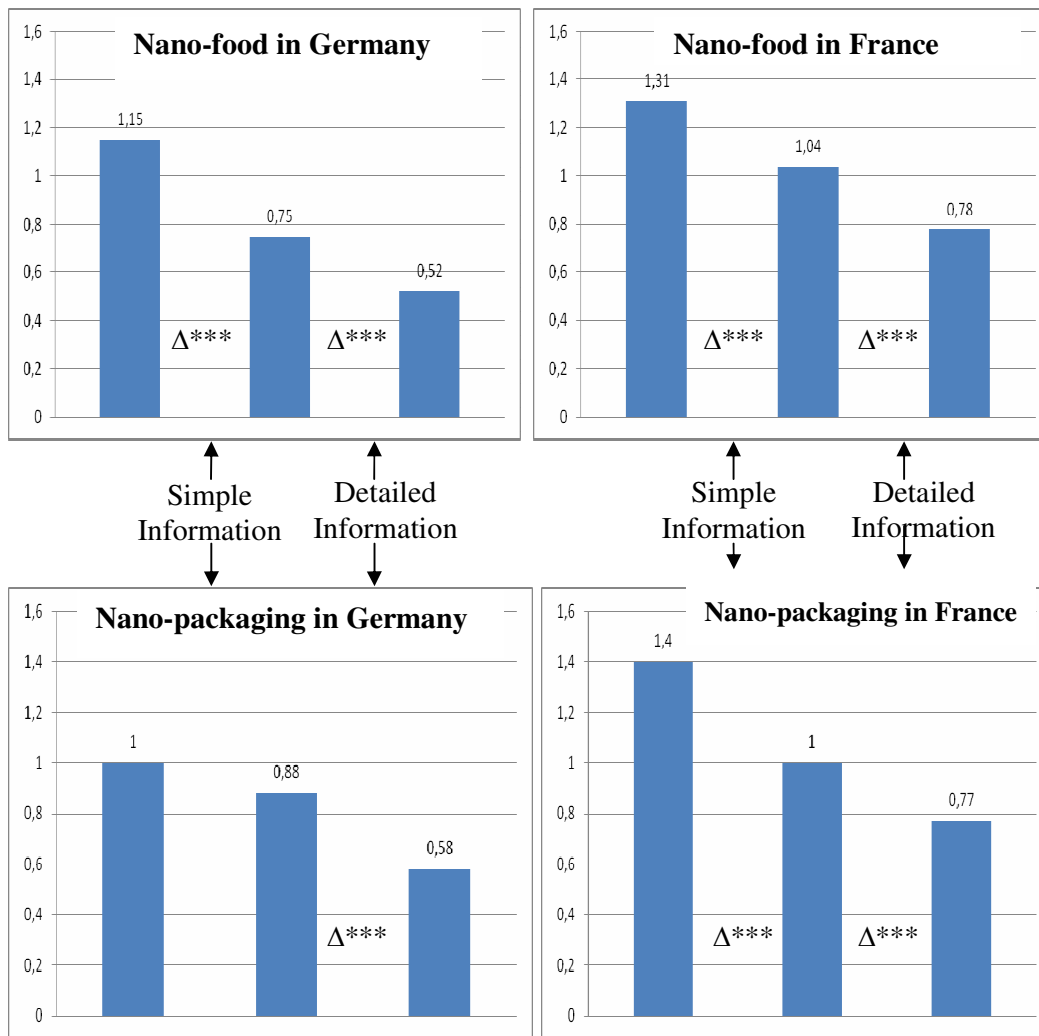
So, the many participants’ mistrust of nanotechnologies is expressed by a sometimes sharp reduction in their WTP. The detailed piece of information targeting health and orange juice safety does not correct that initial feeling. Moreover, this mistrust is shared by German and French participants, which is confirmed by an econometric analysis highlighting the similarity of reactions despite perceptions of risk and profit sometimes being different in Germany and France.

Beyond the analysis of average WTP, an analysis of the participants’ individual WTP allows us to foresee the participants’ choices if “nano-juices” were introduced on the market. On the basis of the WTP obtained with the German experiment, we assess the consumers’ surpluses for the introduction of an orange juice with vitamin D or packaged in an anti-UV bottle thanks to nanotechnologies. The participants’ decision criterion is given by the surplus equal to the WTP minus market price (or a value equal to zero if the WTP is lower than the price). The comparison of the surplus linked to the nano-juice allows an assessment of potential buyers for the new product. The surplus assessment

shows that very few participants would buy the enriched “nano-juices” (only 2% of them) and the juices in “nano-bottles” (5% of them). This is

the minority fringe of participants who do not express any reservations towards that innovation.

**Figure1: Information on nanotechnologies and average willingness-to-pay (€) for a bottle of orange juice**



**Note:**  $\Delta^{***}$  shows significant variations at 1% level according to the Wilcoxon test. In the presence of  $\Delta^{***}$ , the variation between both lines isolates the marginal willingness-to-pay linked to information.

### What consequences for public decisions?

As many participants are mistrustful of such innovations in food products, their potential development is undoubtedly limited. Firms’ potential profits might be low in view of the high costs of the research and development necessary for those innovations. The emergence of these new products is therefore unlikely despite their potential advantages for society. A bold public policy as regards new product safety could be useful to promote this type of innovations in the

food sector. Nano-food safety must be irreproachable in a context of very reluctant European consumers. Such a policy guaranteeing unflinching safety would aim to reassure the little proportion of participants potentially interested in these new products.

Increasing agents’ levels of knowledge of the advantages and risks does not seem sufficient to reduce mistrust or indifference towards these technologies. On the one hand, two of the key-factors shown here concern consumers’ general

behaviour towards sciences and technologies, which may induce some support for nanotechnologies, and, on the other hand, confidence in governmental agencies, which appears crucial to the acceptability of this type of new technologies in the agri-food sector. These results converge with those of many studies carried on during these last thirty years on risk

communication: in a position of uncertainty and controversy, public decision-makers should be careful with modes of participative or deliberative communication. Yet, that communication must go hand-in-hand with a strong policy guaranteeing nano-food safety in a context of mistrust among European consumers.

**Andrea Bieberstein**, Technische Universitaet Muenchen, Germany [bieberstein@tum.de](mailto:bieberstein@tum.de)

**Sandrine Blanchemanche**, INRA, Unité Met@Risk, Paris France [Sandrine.Blanchemanche@paris.inra.fr](mailto:Sandrine.Blanchemanche@paris.inra.fr)

**Stéphan Marette** (corresponding author), INRA UMR210 Economie Publique, F-78850 Thiverval Grignon, France [marette@agroparistech.fr](mailto:marette@agroparistech.fr)

**Jutta Roosen**, Technische Universitaet Muenchen, Germany [JRoosen@tum.de](mailto:JRoosen@tum.de)

**Frédéric Vandermoere**, Ghent University, Ghent, Belgium [Frederic.Vandermoere@UGent.be](mailto:Frederic.Vandermoere@UGent.be)

This Franco German project was co-financed by the ANR (French National Research Agency) and DFG (German District Research Agency)

**For further information:**

*Websites for general information:*

**CNDP**. Commission Particulière du Débat Public. (2010). Nanotechnologies. <http://www.debatpublic-nano.org/> (site accessed November 2010).

**CNRS**. Nanotechnologies et santé. <http://www.cnrs.fr/cw/dossiers/dosnano/> (site accessed November 2010).

*Authors' works:*

**Marette S., Roosen J., Bieberstein A., Blanchemanche S., and Vandermoere F. (2009)**. Impact of Environmental, Societal and Health Information on Consumers' Choices for NanoFood, *Journal of Agricultural & Food Industrial Organization*, 7(2) (2009) Article 11.

**Vandermoere F., Blanchemanche S., Bieberstein A., Marette S. and Roosen J. (2011)**. The public understanding of nanotechnology in the food domain: the hidden role of views on science, technology and nature, *Public Understanding of Science*, 20, 195-206.

**Vandermoere F., Blanchemanche S., Bieberstein A., Marette S., and Roosen J. (2010)**. The morality of attitudes toward nanotechnology: About God, techno-scientific progress, and interfering with nature, *Journal of Nanoparticle Research*, 12, 373–381.