Consumer Attitudes toward Genetically Modified Food in Norway

by

Kristine M. Grimsrud, Jill J. McCluskey, Maria L. Loureiro, and Thomas I. Wahl*

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*Grimsrud: Assistant Professor, University of Guelph, Canada; McCluskey (corresponding author): Assistant Professor, Department of Agricultural Economics, Washington State University; Loureiro: Assistant Professor, Department of Agricultural Economics, Colorado State University; Wahl: Director, International Marketing Program for Agricultural Commodities and Trade (IMPACT) Center. The authors wish to thank without implicating Phil Wandschneider helpful discussion and advice. The authors gratefully acknowledge financial support from the IMPACT Center at Washington State University.

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Abstract

There is a lack of public acceptance of genetically modified (GM) food products in Europe. Using a dichotomous choice contingent valuation methodology, we find that willingness to accept (WTA) for GM food in Norway is positively affected (i.e. a greater discount is required) by higher levels of self-reported risk perceptions toward GM-food and preferences for domestically produced food. The estimation results show that self-reported knowledge about biotechnology increases WTA while higher levels of formal education decrease the WTA for GM-foods. Also, respondents who have a high level of concern about food safety have a higher WTA for GM food. Further, we estimate mean willingness to accept for GM food products. Our results indicate that our sample on average wants a 47.7% discount on GM bread compared to conventional bread. For GM-salmon a 56.0% discount compared to non-GM salmon is necessary.

1. Introduction

The introduction of genetically modified crops to world markets has created a new division between the crop trading countries. The U.S. and Canada have great economic interests in exporting their transgenic crops, however, lack of public acceptance of genetically modified (GM) food products in the European Union (EU) and Japan have already resulted in reduced or curbed demand for GM food products. A suggested remedy has been consumer education about the GM foods safeness. However, the results of the 1996 Eurobarometer survey suggested that more knowledgeable people do not necessarily have a more positive opinion; they just have a more definite opinion about biotechnology (Biotechnology and the European Public Concerted Action Group 1997). A later survey, the 2001 Eurobarometer survey showed that 70.9 percent of Europeans simply do not want GMOs.

Consumer attitudes may be just as important as consumer knowledge. The Eurobarometer survey showed that moral doubts were more important than health risks in shaping public acceptance of gene technology (Biotechnology and the European Public Concerted Action Group 1997). Environmental concerns are also important—in the 2000 Eurobarometer survey, 59.4 percent of EU citizens interviewed said that they thought GMOs could have negative impact on the environment. The European consumer attitudes and behavior toward genetically modified food products are complex, and a better understanding is essential for designing market strategies. This study investigates factors that affect consumer acceptance of GM food in Norway and the discount necessary for consumers to be willing to purchase GM food.

The Norwegian regulations regarding GM foods are somewhat stricter, but overall in accordance with the EU regulations. Differences with the EU are possible because Norway is

not an EU-member. The marketing of derived GM-foods is regulated by the 'Act relating to the supervision and control of food and similar products'[1]. The Norwegian Food Control Authority[2] is responsible for approval to use and market GM food material[3]. GM foods may be approved if their use does not pose health risks to humans. Currently, the Food Control Authority has received several applications for approval of GM-foods, but the applications have been returned requesting more research concerning health risks. A second Law, The Gene Technology Act, regulates the import of living GM-organisms. The Norwegian Gene Technology Act requires that the production and use must be useful for society, ethically defendable, and contribute to sustainable development (Myrmæl and Tveito 2000). The Norwegian Directorate for Nature Management[4] evaluates potential environmental consequences of such import.

The precautionary principle that dominates the Norwegian and the EU environmental and food safety policy, calls for preventive measures to be taken when an activity raises threats or scares even if direct cause-effect relationship has not been scientifically proven. In its strongest and most distinctive forms, the principle imposes a burden of proof on those who create potential risks, and it requires regulation of activities even if it cannot be shown that those activities are likely to produce significant harms (Sunstein 2002). The Precautionary Principle was applied regarding the use of antibiotic marker genes in transgenic crop varieties (Myrmæl and Tveito 2000) because there was a concern that such marker genes could lead to antibiotic resistance in humans. In 1997, all such varieties were banned in Norway, and consequently, Norway did not approve EU-approved genetically modified corn, sweet raps and chicory–three GM food products that all have antibiotic resistant marker genes. Of six additional products later approved

[1] Næringsmiddelloven
[2] Statens Næringsmiddel Tilsyn
[3] GM-material includes food products that do not contain GMO's, but where GMO's are used in the production process.

by the EU, two will not be approved by Norway because of the presence of antibiotic marker genes and for the four others the documentation is considered incomplete. So far, only one transgenic tobacco plant and 11 transgenic carnation varieties are approved for importation (Myrmæl and Tveito 2000).

Although the Precautionary Principle has been applied in the past by the Norwegian Government, the Walløe commission presented a report fall 2000 (NOU 2000) in which they conclude that there are insufficient reasons to apply the Precautionary Principle to imported GM-food products. Their conclusions were partly based on the experiences from the US and Canada where no health consequences have been discovered from use of GM food.

If a GM food product is approved for the Norwegian market, it must be labeled. Since 1997, the requirements are that approved GM food products must be labeled as such if the food products/ingredients contains more than 2% genetically modified materials. The 2% threshold will likely be adjusted to 1% in order to make the Norwegian policy consistent with the EU-policy. The Food Control Authority recognizes that there inevitably are traces of GM material in batches of conventional crops, and they do not require approval in such instances. However, they are continuously evaluating what can be considered "unavoidable trace amounts" of GM material in conventional batches of imported crops.

The goals of this study are to analyze factors that induce consumers to choose GM-food and to estimate Norwegian consumers' relative willingness to purchase GM-food with discounts compared to non-GM food. The paper is organized as follows: We first discuss previous literature on consumer preferences and attitudes towards GM foods and Norwegian attitudes towards food safety. Next, we introduce the survey data that is utilized in this study. We then

[4] Direktoratet for Naturforvaltning

present an empirical analyses of the data; first, factors that affect consumers' willingness to purchase discounted GM food products are analyzed, and second, the mean willingness to accept (or required discount) for GM foods in Norway is estimated. Finally, concluding remarks are offered.

2. Previous Studies

An analogous survey to the Eurobarometer survey was held in Norway[5] in 1993, 1996 and 1999, [NSD Report no 118]. The results show that the skepticism in the Norwegian population toward gene technology is considerable. The percentage of people who thought that gene technology would make society better minus the percentage of people who thought it would make things worse was a negative 32 percent for Norway as opposed to a positive 9 for EU in general. Further, the results of the survey indicate that there are no significant differences between Norway and the EU in general regarding cognitive knowledge about biotechnology. Possibly because of the potential for medical use, the percentage of Norwegian people who support biotechnology is higher than the percentage of people who are against it by 18 percent.

Gruner et al. (2000) investigated how perceptions of GM foods are related to basic motivators or life values in the Nordic countries of Denmark, Finland, Sweden and Norway. In particular, they studied consumer beliefs about GM food products and the motivation for GM food choice decisions. The GM food products considered were cheese, hard candy and salmon. For each of the three products, five product variants were considered: the conventional product, the product where GM is used in the production process but is not present in the final product, the product where GM is present but is not active in the final product, and finally, the product where GM is present and active. Respondents were asked to rank the product varieties and were

also interviewed about their beliefs about each of the products. Gruner et al. (2000) found striking similarities in consumer preferences in Denmark, Finland, Norway and Sweden. For cheese and candy, the consumers acknowledged the benefits of genetic modification such as improved taste, functional benefits, and environmental benefits. However, the benefits of the application of GM in food production could generally not compensate for the negative associations to GM. The conventional product was associated with safety and good health while the GM products gave negative associations including uncertainty, unnatural, diseases/ deformities, loss of species and ecological imbalance.

A further finding of Gruner et al. (2000) was that the degree of genetic modification is important. For all countries, the consumers ranked the conventional product highest despite that only the product description for this product did not explicitly mention any benefits. The product variants where the GM material was present in the final product but not active was ranked medium and the product variant in which the GM material is both present and active was ranked last.

Consumers may be more positive about the use of biotechnology for health purposes. Gruner et al. (2000) found that GM candy with a low calorie content and that could be consumed by diabetics was valued by consumers. Further, they found that consumers might be more negative to genetic modifications related to animals compared with plants. Consumers did not acknowledge the benefits of genetic modification for salmon. The food industry acknowledges the consumer skepticism and does not have any plans at present for developing GMO products for the Norwegian market (Abildgaard 2000).

Only a few studies analyze consumer willingness to pay (WTP) for food products that contain GM ingredients. Burton et al. (2001) studied attitudes toward GM food in the UK. They

[5] Since Norway is not an EU member, Norway was not included in the Eurobarometer surveys.

found that there exist significant differences between organic and non-organic consumers on GM acceptance. Regarding genetic manipulations, they found a considerable difference in consumer acceptance between plant and animal products. Using a choice modeling approach, they elicited WTP for GM-free foods. They concluded that infrequent male organic shoppers would be willing to increase their food bill to avoid animal and plant GM technology by 26%, while female shoppers would be willing to pay an extra of 49.31%. For committed organic shoppers these values increased up to 352.12% for males and 471.95% for females.

Lusk *et al*. (2001) estimated willingness to pay for corn chips made without genetically modified ingredients. In their experimental study, junior and senior-level agricultural economics students at Kansas State University indicated their maximum WTP by exchanging a bag of GM corn chips for a bag of GM-free corn chips. They found that an individual who is very concerned about GM foods would be 50% more likely to be willing to pay a premium to exchange GM chips for non-GM chips than an individual with little concern for GM foods. However, their results indicated that 70% of all participants state that they are not willing to pay a premium for non-GM chips. The average bid to exchange GM chips for non-GM chips is $0.07/oz. Still, 20% of participants were willing to pay at least $0.25/oz. for the exchange, and 2% offered bids of $0.50/oz., suggesting that there may be a potential niche market in the United States for GM-free food products.

Baker and Burnham (2001) investigate U.S. consumers' acceptance of GM corn flakes and found that that 30% of consumers based their purchasing decision on GM content. Their analysis shows that cognitive variables (opinions, beliefs, knowledge) have a great influence on consumer preferences. The level of risk aversion, knowledge about genetic modification and opinion about genetic modification were highly significant in explaining the purchasing decision.

Previous studies that investigate the relationship between consumer characteristics and food safety concerns generally find that sociodemographic variables (like education and income) perform poorly as explanatory variables for purchasing decisions regarding GM food products. The exception is that women in general are more concerned with food safety.

3. Choice Modelling and Willingness to Accept

The contingent valuation method (CVM) is a standard approach to elicit people's willingness to accept (WTA) through dichotomous choice, market-type questioning format with a direct survey such as via telephone, mail, and in-person questionnaire (Kanninen 1993). In the dichotomous choice CVM, each respondent is asked whether or not he/she would be willing to accept a particular discount for a particular good in a hypothetical market, letting him/her answer with "yes" or "no" along with the discounts "bid" amounts offered to each individual.

The most commonly used bidding methods used in the CVM are the single-bounded and double-bounded dichotomous choice with the double-bounded model gaining popularity (Kanninen 1993). The single-bounded model approach recovers the bid amount as a threshold by asking only one dichotomous choice question (Hanemann , Loomis, and Kanninen 1991). The statistical efficiency of this approach can be improved by use of the double-bounded model, which engages in two bids.

Our survey included contingent valuation questions regarding willingness to accept a discount to purchase bread made from genetically modified wheat and salmon fed feed containing genetically modified soybeans. The hypothetical market for the good in question must be as close as possible to a real market in order to reveal people's true preferences if an actual market existed (Pearce and Kerry 1990). The food products (bread and salmon) used in

this study are appropriate to be examined since they are frequently consumed food products by the most Norwegians. Bread is an everyday food in Norway, and 46% of the respondents have salmon at least once a week while 35% have salmon at least once a month.

First, consumers were asked if they were willing to purchase the GM-food product if offered at the same price as the corresponding, non-GM product. If the respondent's answer to this question was "no," a follow-up question was asked if the respondent was willing to purchase the GM-food product if offered a percentage discount compared with the corresponding, non-GM product. The discount was set at one of the following levels: 5%, 10%, 25%, 40%, and 50%. Each level of discount was used for one fifth of the surveys. That is, eighty of the 400 surveys had a 5% discount for GM salmon, another 80 surveys had a 10% discount for GM salmon, and so on. The assignment of survey version (and thus, discount) was random to the respondent. The maximum discount was set 50%, assuming that people who would not prefer the GM food product at such at large discount would not choose the product at any discount. No follow-up question was asked if the customer's answer was "yes" to the initial question, and he/she was willing to purchase the GM food product at no discount. The rationale for no follow up to a "yes" response is that the type of genetic modification associated with these GM food products is a *process attribute*, which reduces production costs—as opposed to a *product-enhancing* attribute. An example of a GM product with a product-enhancing attribute is the Flavr Savr Tomato. Proponents claim that the GM products with process attributes are identical to non-GM products. Opponents view genetic modification as a negative attribute. Therefore, it would not make economic sense after an initial "yes" respond with a follow-up question that involves paying a premium for these GM products that only have cost-reducing attributes.

Surprisingly, of the 400 respondents, more than one fourth of the sample would buy bread with genetically modified wheat flower when offered no discount compared to conventional bread, and one-fifth of customers in the sample are willing to purchase salmon fed feed containing genetically modified ingredients at no discount. Further, 39% (for bread) and 31% (for salmon) of consumers in the sample replied that they would be willing to purchase the GM products if they were cheaper than the conventional products. The rest of the respondents, that is 61% for bread and 67% for salmon, claimed that even with the discount offered, they were unwilling to purchase the GM product. For more specific statistics on the distribution of responses over the various discounts, see Table 1.

3.1 Econometric Model

There are three possible outcomes in our methodology instead of the four possible outcomes in the standard double-bounded model: (1) the respondent is willing to purchase the GM product at the same price as the non-GM product implying a "yes"; (2) the respondent is not willing to purchase the GM product neither at the same price but is willing to buy the GM food product at the random discount offered, i.e. a "no" followed by a "yes"; (3) the respondent is not willing to purchase the GM product neither at the same price nor at a discount relative to the non-GM product, i.e. "no" to both bids.

The model that is applicable to examine the outcomes of our survey can be considered a special case of the double-bounded logit model (Hanemann, Loomis, and Kanninen 1991). In this model, the initial bid (B_0) equals zero and implies no price difference between GM and the corresponding, non-GM food products. The second bid (B_D), is the GM-food product offered at a random percentage discount relative to the corresponding, non-GM food product. This bid is

only given to those individuals who answer that they would not buy GM food products at equal prices. We refer to this model as a 'semi-double-bounded' model. Modeling of this type has been around in the literature since at least Cameron and Huppert (1989) and is envisioned in the multiple bounded discrete choice modeling in Welsh and Poe (1998).

The sequence of questions isolates the range in which the respondents the true WTA discounts for GM products relative to non-GM food products lie. The discount for the GM product relative to the non-GM product can be zero, B_0, or it can be located in one of the intervals $(B_0, B_D]$, $(B_D, +\infty)$ where B_D is the discount bid offered. The second bid, B_D, in conjunction with the response to the initial preference decision, allows bounds to be placed on the respondent's unobservable true WTA for GM food. The lower bound on the WTA discounts for GM food was determined *a priori* as no discount on GM-food in comparison to non-GM food because it is assumed that the genetic modification did not add any value to the product for the customer. Note that a discount greater than 100% can be interpreted as that the respondent would need to be paid to choose the GM product.

Let WTA_g denote an individual's WTA (or bid function) for the particular GM-food product g, $g \in \{\text{GM - bread}, \text{GM - salmon}\}$, relative to the non-GM product and $B_D \leq 0$[6] denotes the discount bid on the GM food product relative to the non-GM food product. The following discrete outcomes of the bidding process are observable for each product g:

$$(1) \qquad D_g = \begin{cases} 1 & WTA_g \leq B_0 \\ 2 & B_0 < WTA_g \leq B_D \\ 3 & B_D < WTA_g \end{cases}$$

Respondents who indicate the lowest WTA for GM foods (i.e. the smallest required discount to choose GM foods) fall into the first group, because they are willing to purchase the GM-food product at zero discount compared to the non-GM food product. Those who fall into the second group indicate an intermediate WTA for GM foods. In order to choose the GM product, the price of the GM products must be discounted relative to the corresponding non-GM food product by an amount less than or equal to the discount bid. Finally, those who indicate the highest WTA (i.e. the largest required discount to choose GM food) fall into the third group. Customers in this group are not willing to purchase the GM-product at the discount offered.

The WTA function for each food product *g*, individual *i* is

$$(2) \qquad WTA_{gi} = \alpha_g - \rho_g B_{gi} + \boldsymbol{\lambda}_g' \mathbf{z}_i + \varepsilon_{gi} \quad i = 1,...,n$$

where B_{gi} is the ultimate discount bid individual *i* faces for food product *g*, $\mathbf{z}_i$ is a column vector of observable characteristics of the individual, ε_{gi} is a random variable accounting for random noise and possibly unobservable characteristics. Unknown parameters to be estimated are α_g, ρ_g, and $\boldsymbol{\lambda}_g$. Linearity in $\mathbf{z}$ and ε is assumed, for both food products and all individuals. Furthermore, the distribution of the error term is assumed to follow $\varepsilon \sim G(0,\sigma^2)$, where $G(0,\sigma^2)$ denotes a

[6] The randomly assigned discount bids were $B_D = \{0.05,0.1,0.25,0.4,0.5\}$, or expressed as percentages, 5%, 10%, 25%, 40%, and 50% of discount compared to the price of the conventional product.

cumulative distribution function with mean zero and variance σ^2. Under these assumptions, the choice probabilities for product *g* individual *i* can be characterized as[7]:

$$(3)\qquad \text{Prob}(D_{gi}=j)=\begin{Bmatrix} G(\tilde{\alpha}_g-\tilde{\rho}_g B_{0i}+\tilde{\boldsymbol{\lambda}}_g'\mathbf{z}_i) \\ G(\tilde{\alpha}_g-\tilde{\rho}_g B_{Di}+\tilde{\boldsymbol{\lambda}}_g'\mathbf{z}_i)-G(\tilde{\alpha}_g-\tilde{\rho}_g B_{0i}+\tilde{\boldsymbol{\lambda}}_g'\mathbf{z}_i) \\ 1-G(\tilde{\alpha}_g-\tilde{\rho}_g B_{Di}+\tilde{\boldsymbol{\lambda}}_g'\mathbf{z}_i) \end{Bmatrix} \text{for } j=\begin{Bmatrix}1\\2\\3\end{Bmatrix}$$

Thus, the log-likelihood function becomes:

$$(4)\qquad L_g=\sum_i \begin{Bmatrix} I_{D_i=1}\ln G(\tilde{\alpha}_g-\tilde{\rho}_g B_{0i}+\tilde{\boldsymbol{\lambda}}_g'\mathbf{z}_i) \\ +I_{D_i=2}\ln\left[G(\tilde{\alpha}_g-\tilde{\rho}_g B_{Di}+\tilde{\boldsymbol{\lambda}}_g'\mathbf{z}_i)-G(\tilde{\alpha}_g-\tilde{\rho}_g B_{0gi}-\tilde{\boldsymbol{\lambda}}_g'\mathbf{z}_i)\right] \\ +I_{D_i=3}\ln\left[1-G(\tilde{\alpha}_g-\tilde{\rho}_g B_{Dgi}+\tilde{\boldsymbol{\lambda}}_g'\mathbf{z}_i)\right] \end{Bmatrix}$$

where I_K is an indicator function for the event *K*, and $D_i = j$ denotes that the j^{th} alternative occurred. In the empirical implementation of the model, we define $G(\cdot)$ to be the standard logistic distribution function with mean zero and standard deviation $\sigma=\pi/\sqrt{3}$.

4. The Application

In January 2002, we conducted a survey at a Norwegian grocery store, RIMI Liertoppen, in the Oslo-region of Norway. This region is the most populated part of Norway and one of the

[7]The condition of linearity on z is a simplifying assumption widely used in RUM (random utility models). This assumption implies that consumer's willingness to accept *c* dollars is generally represented as:
$U(0,x_0,m)\le U(1,x_1,m+c)$, $\Pr\{WTA\le c\}=\Pr\{V_0+\varepsilon_0\le V_1+\varepsilon_1\}=\Pr\{\varepsilon_1-\varepsilon_0\le V_0-V_1\}$ where $V_0-V_1=\alpha+\beta c$.

Norwegian centers of economic activity. The survey data was collected with in-person interviews. By collecting data from consumers at the same time and place where actual purchase decisions are made, we hoped to better elicit consumers' true preferences about the products. Respondents were selected randomly with the criterion that the interviewer was to solicit every third customer who came in the survey area, and the turndown rate was about 5%. After the survey was completed, every respondent was given a gift certificate (worth approximately $5 in Norwegian Kroner).

In total, 400 consumers were surveyed. The majority of respondents are the primary food shoppers of the household (82%) and female (69%). Eighty-four percent of the shoppers in the survey shop for groceries daily or between two and five times a week. The respondents' average age is 41.6 years, which is close to the average age of 44 years for the general population of Norway in 1998. Fifty-seven percent of all respondents have children under the age of 18 years living in their household. The most frequent range of household income as a whole family is between 450,000 Norwegian Kroner (U.S. $50,300) and 600,000 Norwegian Kroner (U.S.$67,100)[8] for the 2001 fiscal year. This range is slightly higher than the average Norwegian income; in 1999, the average income for all households was Norwegian Kroner 381,500 which when inflated to 2001 represents an income of Norwegian Kroner 405,367. The most frequent level of education includes two to three years of college. This level of education may be somewhat higher than the national average; in 1998, the most frequent level of education completed was secondary school. The dataset contains 381 usable observations. Summary statistics and variable descriptions are presented in Table 2.

[8]In order to obtain a high response rate, respondents were asked to place themselves in income intervals, rather than state their exact income amount. Survey respondents are typically reluctant to divulge incomes information. The exchange rate used is $1= 8.941 kroner.

The survey asked for information about respondents' attitudes about the environment and food safety, their self-reported knowledge and perceptions about the biotechnology (see Table 3). Information about environmental and food safety attitudes was obtained by presenting trade-off situations between environmental quality and economic growth, and between food safety and low prices, respectively (see the appendix for English translation of the tradeoff questions). We find that 58% of the customers assign more importance to economic growth than preserving the environment, and 68% placed more importance on food safety issues than price. Eliciting these attitudes with trade-off scenarios is an effective way of ensuring that the survey information is informative as well as useful in an empirical modeling context. For example, without the tradeoff, most respondents will say that they value the environment highly. The resulting lack of variation in response can lead to a lack of statistical significance.

As in all surveys, sample representativeness is of concern. One possible sample bias is the population choice bias, in which the population sampled does not adequately correspond to the population that would purchase genetically modified food products. The RIMI chain of grocery stores has chosen a low-price/limited-selection niche in the market and has in this way gained significant power in the Norwegian marketplace. Although the store-selection is wide enough to include all the most frequently consumed foods in Norwegian households, the chain does not focus on specialty products, such as organic and ecologically produced foods. This potential bias may be mitigated by the location of the grocery store at a mall where many different people drop by to pick up a few grocery store items. Another potential concern with respect to population bias is that the geographical location of the chosen grocery store. The store is located in one of the major agricultural production areas in Norway. However, the specific store chosen is also located in a major shopping mall for the region including the city Drammen

and the capital Oslo. Given the preceding concerns, we acknowledge that the extent to which the findings can be fully generalized to broader populations is uncertain.

5. Empirical Analysis

The empirical analysis associated with this research is divided into two sub-sections. The first analyses factors that affects consumers' willingness to accept discounts to purchase GM-foods, and the second estimates of Norwegian consumers willingness to accept discounts for GM-foods.

5.1 Analysis of Factors that Affect WTA for GM-food

The bid information and other demographic information were used to estimate the magnitude of factors that affect Norwegian consumers' WTA for GM-food products and how much of a relative discount Norwegian consumers will require to purchase GM food products. We present an analysis of factors that affect WTA for GM-bread only since we have more usable observations for bread than for salmon, and the responses are similar.

The variables included in the model were self-reported knowledge about GMO, opinion regarding use of biotechnology in food production, self-reported risk perceptions about biotechnology, preferences for domestic versus imported food, education level, and gender. The model (2) was estimated where

$\mathbf{z}_i = \{Knowledge_i \quad Opinion_i \quad Risk_i \quad Domestic_i \quad Education_i \quad Gender_i\}$. Variable definitions and descriptions are given in Tables 2 and 3. Parameters to be estimated are $\boldsymbol{\lambda}' = \{\lambda_1 \quad \lambda_2 \quad \lambda_3 \quad \lambda_4 \quad \lambda_5 \quad \lambda_6\}$ in addition to α, ρ. Additional variables are difficult to include because of convergence problems. The parameter estimates are reported in Table 4.

Increasing self-reported risk perceptions toward GM-foods and preference for domestically produced food both significantly increase the WTA for GM-foods (i.e. a greater discount is required). These results are consistent with the general skepticism to GM-foods found by Gruner et al. (2000). Interestingly, the estimation results show that self-reported knowledge about biotechnology increases WTA while higher education levels decrease the WTA for GM-foods. This may indicate that the self-reported knowledge has been obtained from sources that negative to biotechnology and/or genetic modification. The discrepancy in willingness to purchase genetically modified food between people with high self-reported knowledge and people with higher education may indicate that consumer education may increase consumers' willingness to purchase GM-foods. The coefficient for *Gender* (indicating female) is positive although not significant at conventional levels.

5.2 Estimates for Mean WTA for GM-food

The mean willingness to accept for both GM food products, WTA_g, where g= {bread, salmon}, was estimated by restricting $\lambda_g = 0$ (Hanemann, Loomis and Kanninen 1991). The empirical mean WTA_g can then calculated as $\tilde{\alpha}_g / \tilde{\rho}_g$. Our results indicate that on average the consumers in our sample want a 47.7% discount on GM bread compared to conventional bread. For GM-salmon a 56.0% discount compared to non-GM salmon is necessary (see Table 5). The increase in probability of accepting the discount bid offered over the range of bids given is displayed in Figure 1. The figure shows that the discount required for salmon is generally higher than the discount needed for GM bread and the reason may be that many people are more skeptic to genetic modification associated with animals than with plants (Gruner et al. 2000, Burton et al. 2001). Further, there seemed to be a general distrust in the fish farming industry; most people

(84%) said that they believed that salmon had been fed food containing genetically modified ingredients despite that such feed is illegal in Norway.

The high discounts are reasonable given how relatively few people indicated their willingness to purchase GM foods either at the equal prices or discounted prices (see Table 3). Ideally, the mean WTA would be contained within the discounts offered. However, the partitions cover all the ranges of the WTA distribution. The "no, no" group likely includes people who would not choose GM foods if they were given away for free. This group is included in the lower-bound partition of willingness to accept.

Although the skepticism towards GM food in the Norwegian population currently seems strong, this may be a fading trend. An indication of this is an age-relationship in the data (see Table 5). To be willing to purchase GM bread, respondents below the average age of 41.6 years on average only need a discount of 31.8% while for customers older than the average age the average discount needed is 88.0%. We see the similar effects for salmon. The average discount needed for GM-salmon is 44.3% for customers below the average age of the data set and 83.6% for customers above the average age.

The confidence intervals for the WTA estimates are given in Table 5, and were calculated using 1000 bootstrap samples. The standard deviation of the average WTA for the 1000 bootstrap samples was used to calculate 95% confidence intervals[9] (assuming asymptotic normality of these averages WTA estimates).

[9] CI= $\tilde{\alpha} / \tilde{\rho} \pm 1.96 * SE_{Bootstrap}$

6. Conclusions

A better understanding of Norwegian consumers' attitudes and behavior toward genetically modified food products and how these attitudes affect the purchasing choices for such food products is essential for marketing GM food products in Norway. This study analyzes factors that affects Norwegian consumers' WTA for GM food products and estimates their WTA (the discount required to choose the GM products).

The Norwegian policy restricting GM food products and the results of surveys show that there is a considerable skepticism in the Norwegian population toward GM foods. The results of this study suggests that our sample of Norwegian consumers are, on average, willing to purchase GM bread with a 47.7% discount and GM salmon with a 56.0% discount compared to the corresponding non-GM product. Consumers' perceptions and attitudes toward GM-food and respondents' age increase WTA (that is, a greater discount would be required) for GM-food.

The strong skepticism in the Norwegian population may be fading, leaving a potential future market for GM foods. People younger than the average age of the sample were willing to purchase the GM food products with an average discount that is half (or less) of what the customers above the average age of the sample needed. The gap in between generations for WTA, indicate that younger people may be more open to GM foods and that it may a question of time before the Norwegian market may be more open to GM food products.

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Table 1. Range and Distribution of response rates to the randomly assigned discount offer

Question	Percentage of Yes-responses for Each Discount		
	Discount	Bread	Salmon
Initial Question	0%	26.8%	17.8%
Second Question	5%	10.8%	4.8%
	10%	11.9%	14.3%
	25%	19.7%	16.4%
	40%	17.9%	23.8%
	50%	26.9%	20.6%

Table 2: Summary Statistics for the Demographic Variables

Variable	Description	Descriptive Statistics
Age	Age of the consumer	Mean: 41.6 years St. Dev : 12.9 years
Gender	0 if female, 1 if male	69.3 % females 30.8 % males
Shopper	1 if main shopper 0 otherwise	82.3 % main shoppers 17.8 % not main shopper
Education	compulsory school HS diploma 2-3 year college 4-5 year degree Adv./Prof. degree refuse 0=compulsory school, HS diploma, refuse 1=2-3, 4-5 year college, Adv./Prof. degree	15.5 % 29.3 % 32.1 % 20.1 % 2.3 % 0.5 %
Children	1 if children <18 in the household 0 otherwise	56.8 % 43.3 %
Household Size	Number of people in the household	Mean: 3.14 St. Dev. 1.37
Income	1 = < 150 NOK 2 = 150-300,000 NOK 3 = 300-450,000 NOK 4 = 450-600,000 NOK 5 = 600-750,000 NOK 6 = 750-900,000 NOK 7= > 900,000 NOK	3.6 % 19.5 % 23.6 % 27.7 % 13.2 % 6.9 % 5.6 %

Table 3: Summary Statistics for Consumer Information and Perception Variables

Variable	Description	Scaled Values	Descriptive Statistics
Environment	Importance of environmental sensitivity vs. economic growth	(1,2,…,10) 1=Economic growth 10 = Preserve environment	Mean: 6.1 St. Dev.:1.97
Food Safety	Importance of food safety versus price	(1,2,…,10) 1=Food safety 10=Cheaper food	Mean: 4.51 St.Dev.: 2.95
Risk	Risk Associated with GMOs. No risk, some risk, or high risk	1= High risk 0 = Some, no risk, don't know	Mean: 0.48
Opinion	Favorable Opinion toward Use of Biotech in Food Production	1 = Very, somewhat positive, neutral, don't know 0 = Somewhat, very negative	Mean: 0.50
Knowledge	Self-Reported knowledgeable about biotechnology	1= Know a lot, know something 0 = Know little	Mean: 0.61
Labeling GMO	Views about the Importance of labeling GM foods	1 = Very important 0 = Somewhat, not important	Mean: 0.87
Domestic	Preference of domestic vs. imported food products	1 = Yes 0 = No	Mean:0.74

Table 4. Parameter Estimates for WTA Model

Parameter	Variable Description	Estimate	t-value	p-value
$\tilde{\alpha}$	*Intercept*	0.9079	2.42	0.0076
$\tilde{\rho}$	*Discount Bid*	2.3699	7.685	0.0000
$\tilde{\lambda}_1$	*Knowledge*	0.3339	1.397	0.0812
$\tilde{\lambda}_2$	*Perception*	-1.2469	-5.142	0.0000
$\tilde{\lambda}_3$	*Risk*	1.3188	4.292	0.0000
$\tilde{\lambda}_4$	*Domestic*	0.5574	2.193	0.0142
$\tilde{\lambda}_5$	*Education*	-0.3760	-1.522	0.0641
$\tilde{\lambda}_6$	*Gender (male)*	-0.1629	-0.676	0.2495

Table 5: WTA Premium for GM Bread and Salmon (%) with Confidence Intervals

Estimated from Semi-Double Bounded Model	$\tilde{\alpha}$	$\tilde{\rho}$	Average Discount needed $=(\tilde{\alpha}/\tilde{\rho})$	Bootstrap SE for average discount	95% Confidence Interval
GM bread	0.9960	2.0894	0.4767	0.0633	(0.3526,0.6008)
GM bread, below average age of the sample	0.8654	2.7226	0.3179	0.0580	(0.2042,0.4316)
GM bread, above average age of the sample	1.1297	1.2837	0.8800	0.1501	(0.5858, 1.1742)[10]
GM salmon	1.4103	2.5192	0.5598	0.1025	(0.3589,0.7607)
GM salmon, below average age of the sample	1.2127	2.7342	0.4435	0.0675	(0.3112,0.5758)
GM salmon, above average age of the sample	1.5740	1.8834	0.8357	0.1195	(0.6015,1.070)

[10] A discount above 100% means that the person is not willing to accept the product regardless of how much discount is offered.

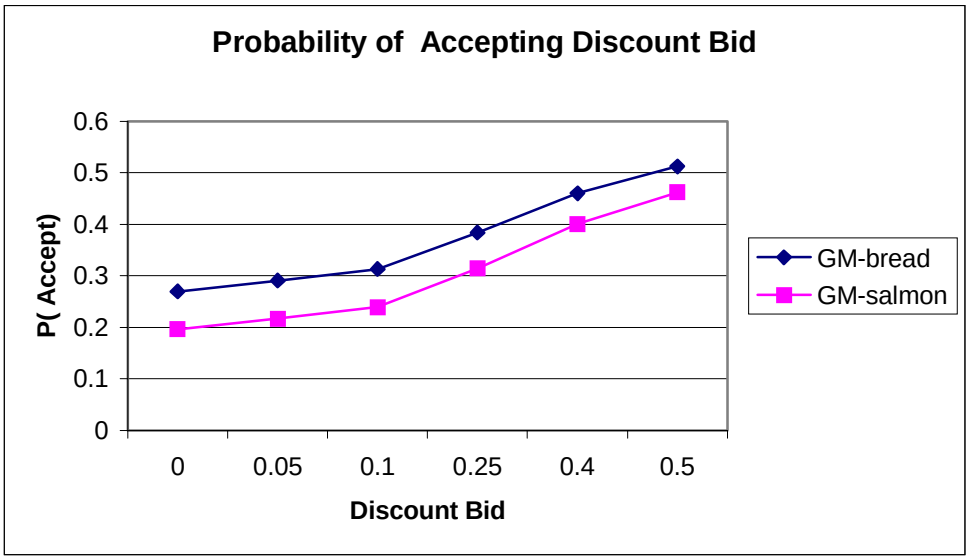

Figure 1: Probability of Accepting the Given Discount Bid for GM-bread and GM-salmon.

APPENDIX A

QUESTIONS USED TO ELICIT FOOD SAFETY AND ENVIROMENTAL ATTITUDES

Where would you place yourself on a scale from 1 to 10, **if economic growth at all costs is a 1** and **saving the environment at all costs is a 10**. (CIRCLE JUST ONE)

1 2 3 4 5 6 7 8 9 10

When you are purchasing food, how important are lower **food safety** risks versus **lower cost food** on a scale of 1 to 10, where **1 means lower food safety risk is all important** and **10 means lower food prices are all important**? (CIRCLE JUST ONE)

1 2 3 4 5 6 7 8 9 10

QUESTIONS ABOUT GMO KNOWLEDGE AND ATTITUDES

How knowledgeable are you about biotechnology and genetically modified (GM) foods?

1. Very knowledgeable
2. Somewhat knowledgeable
3. Not informed

Overall, how do you feel about the use of biotechnology in foods?

1. Very positive
2. Somewhat positive
3. Neutral
4. Somewhat negative
5. Very negative
6. Don't know

How much risk, if any, do you associate with genetically modified foods?

1. High level risk
2. Low level risk
3. No risk
4. Don't know

How important is it to you for foods with genetically modified ingredients to be labeled?

1. Very important
2. Somewhat important
3. Not very important

Do you prefer domestic to imported food products?

1. Yes
2. No

QUESTIONS RELATED TO WILLINGNESS TO ACCEPT

A U.S. university is developing genetically engineered wheat. Would be willing to purchase bread made with this wheat if it is offered at the same price as bread without genetically engineered wheat?

1. Yes (skip to salmon questions)
2. No

Would you be willing to purchase this bread if it was offered at a price that is **[INSERT RANDOM DISCOUNT]** less than bread without genetically engineered wheat?

1. Yes
2. No

Would you be willing to purchase salmon that has been given feed containing genetically modified ingredients (genetically modified soy) if it is offered at the same price as salmon that had not been given feed containing genetically modified ingredients?

1. Yes (skip to demographic questions)
2. No

Would you be willing to purchase salmon that has been given feed containing genetically modified ingredients if it is offered at a price that is **[INSERT RANDOM DISCOUNT]** less than salmon that has not been given feed containing genetically modified ingredients?

1. Yes
2. No
