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Consumer Willingness to Pay for Genetically Modified Vegetable Oil and Salmon in the United States and Norway

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Consumer resistance against GM crops is still substantial in the United States and Europe. We conducted an internet survey in the United States and Norway with more than 1,000 respondents in each country to estimate consumers' willingness to pay (WTP) for GM soybean oil, farmed salmon fed with GM soy, and GM salmon. The differences in WTP for the conventional as compared with the GM alternatives are relatively small. Only between 7 and 13% of the respondents indicated that they were willing to pay more than a 20% premium for each of the conventional alternatives as compared to the corresponding GM alternatives. The average WTP premiums range from 7.5 to 9.2%. This suggests a large similarity in WTP in Norway and the United States and across the three products.

Key words: consumer attitudes, genetically modified foods, salmon, soybeans, stated preference, willingness to pay.

Introduction

Genetically modified organisms (GMOs) have been a topic of great interest to researchers, food marketers, and policymakers since the 1990s. Despite the controversies and opposition from various interest groups, the adoption of GMOs in the world has been phenomenal. According to the US Department of Agriculture (USDA, Economic Research Service [ERS], 2017a), at least 90% of all soybeans, corn, and cotton planted in the United States are of genetically modified (GM) varieties. As shown in Table 1, global GMO crop production has increased 100-fold from the initial planting of 1.7 million hectares in 1996 to 179.7 million hectares in 2015. Hence, GMO crops are now considered as the fastest adopted crop technology in the history of modern agriculture (ISAAA, 2016).

GM soybean accounted for about half of all the biotech crop area in the world in 2015. The country growing the largest acreage of GM soybean is the United States, where the acreage has increased rapidly from 4.8 million hectares in 1997 to 31.5 million hectares in 2015. Based on USDA survey data, GM soybean production in the United States went from 17% of US soybean acreage in 1997 to 68% in 2001, and then to 94% in 2015/2016 (USDA ERS, 2017a).

The use of GM soybeans in Norwegian aquaculture is an issue of great importance for a rapidly expanding sector. As seen in Table 1, the production of farmed Atlantic salmon in Norway has increased from less than 300,000 tons in 1996 to more than 1,300,000 tons in 2015. The share of global production has for most of the period been more than 50%. Approximately 75% of the world's soybean production is used in animal feed mainly for poultry, pig, and ruminants. In Norway, about 70% of the imported soy is used in fish production, and the fish feed contains about 25% soy, mainly in the form of soy meal (Salmon Facts, 2016a). However, GM soybeans cannot be used in the fish feed without approval from the Norwegian Food Safety Authority, and currently no GM ingredients are approved. Until 2014, fish feed companies could apply to use EU-approved GM feed ingredients as a safety mechanism for insufficient conventional feed on the world market; however, nobody applied and so this exemption was removed. Given a rapidly expanding aquaculture sector, it may be difficult to obtain feed ingredients that are not GM, so there may be a need for a policy change (Salmon Facts, 2016b). Non-GM feed is also more expensive in the market (Marine Harvest, 2016).

GM technologies have also been used to engineer a GM salmon. The main advantage of this salmon is more rapid growth and less use of feed as compared with the non-transgenic Atlantic sibling. The GM salmon, which was developed by the US company AquaBounty, is the only GM animal that has been approved for human consumption (Jalonick, 2015). The fish was created in 1989 and AquaBounty applied for a US Food and Drug Administration (FDA) approval in 1995. The FDA then decided that the GM salmon was safe to eat in 2010 (Ledford, 2013) and also decided in November 2015 that there is no biologically relevant difference in the nutritional profile between the AquaAdvantage salmon and other farmed Atlantic salmon. Although the salmon has been approved for sale in the United States and Canada, there is currently a ban for its import to the United States until the FDA mandates labels for this GM prod-

Table 1. Area of GM crops, GM soybeans and production of farmed Atlantic salmon.

Year	GM crops (mill ha) World[a]	GM soybeans (mill ha) World[b]	GM soybeans (mill ha) US[c]	Atlantic salmon (1,000 tons) World[d]	Atlantic salmon (1,000 tons) Norway[d]
1996	17.7		-	551.9	297.6
1997	11.0		4.8	646.5	332.6
2000	44.2		16.2	895.8	440.1
2005	90.0	54.4	25.4	1,267.3	586.5
2010	148.0	73.3	29.2	1,437.1	939.5
2015	179.7	92.0	31.5	2,381.6	1,303.3

Sources: [a] James (2015). [b] Statista (2017). [c] Authors calculations based on USDA ERS (2017a, 2017b).
[d] Food and Agriculture Organization of the United Nations (2017).

uct (Wikipedia, n.d.). Even with regulatory approval, the success of the GM salmon is still unclear due to concerns about consumer acceptance. According to Borrell (2014), 65 US supermarkets have signed a pledge not to sell it.

Hence, despite the success of GMO development, adoption, and production worldwide, there are still significant uncertainties in regards to consumer acceptance. There is considerable literature about consumers' acceptance of GM foods (e.g., Canavari & Nayga, Jr., 2009; Chern, Rickertsen, Tsuboi, & Fu, 2002; Frewer, Howard, & Aaron, 1998; Knight, Mather, Holdsworth, & Ermen, 2007; Lewis, Grebitus, & Nayga, Jr., 2016; Nayga, Gillett-Fischer, & Onyango, 2006; Onyango & Nayga, Jr., 2004; Wolfe et al., 2017). For example, Gaskell et al. (2006) reported that Europeans generally consider GM food as risky and not morally acceptable, and a majority disagreed with the idea that the development of GM food should be encouraged. On the other hand, Knight et al. (2007) reported that European consumers are actually willing to consume GM food if the product was both cheaper and provided an environmental benefit (e.g., spray-free fruits). In the United States, the Pew Initiative on Food and Biotechnology (2001) used a large-scale US survey and found that more than half of the respondents had little experience with talking about GM foods or biotechnology. Such findings have influenced economists in the United States to conduct valuation experiments to assess consumers' willingness to pay (WTP) for GM foods (e.g., Delwaide et al., 2015; Lusk et al., 2004; Rousu, Huffman, Shogren, & Tegene, 2006; Shew et al., 2016; Wolfe et al., 2017; Xie, Kim, & House, 2013).

Of particular interest for this study are the results in Chern et al. (2002), who investigated consumer acceptance and WTP in two surveys. These surveys included GM soybean oil, GM-fed salmon, and the GM salmon and were conducted in Norway and the United States in 2000 and 2002. The surveys included 256 US and 200 Norwegian respondents and were conducted by telephone. A logit model was estimated, and they found that the respondents were willing to pay premiums that sometimes exceeded 50% for conventional as compared with the GM alternatives.

Given questions and issues regarding consumer acceptance of and WTP for GM foods, it is not surprising that a number of countries have required GM labeling (e.g., EU). GM labeling is also becoming a very important issue in the United States given that the US Congress recently passed a bill that will establish national standards for labeling food containing GM ingredients (Wolfe et al., 2017). A number of studies in many countries have found that a large majority of consumers support mandatory labeling of GM food (e.g., Chern et al., 2002).

In this study, we have three main objectives. First, we will examine consumer attitudes and WTP for GM soybean oil, salmon fed with GM soybeans (for short GM-fed salmon), and GM salmon in Norway and the United States.

Second, we will investigate to what extent attitudes and WTP for GM products have changed over the last 15 years in the United States and Norway. During this period there has been increased production and consumption of GM foods in the United States while there has been no production or consumption in Norway. Norway is also a European country that can be contrasted with the United States. The European Commission's Eurobarometer reports suggest that European consumers' opinion on GM foods has evolved in such a manner that they became more averse to GM products over time (Delwaide et al., 2015). Furthermore, the use of soybeans and other plant-based feed has increased rapidly in salmon farming and non-GM soybeans are more costly to buy in the market. GM salmon is also now ready for the market.

Table 2. Consumer attitudes, percentage distributions.[a]

	Totally disagree	Somewhat disagree	Somewhat agree	Totally agree	Impossible to answer	*p*-value[b]
Food is too expensive in the United States (Norway).						
US	4.5	17.6	40.8	34.8	2.2	
Norway	12.2	25.7	35.8	25.7	0.8	0.00
It is important that the United States (Norway) utilizes biotechnology opportunities to create improved animals and plants.						
US	13.7	16.3	39.8	23.1	7.1	
Norway	13.0	20.0	35.7	19.3	12.1	0.04
The nutritional content is important when I buy food.						
US	2.7	8.6	38.2	48.2	2.3	
Norway	1.9	8.3	42.3	46.7	0.8	0.58
I am willing to consume genetically modified foods if they were more nutritious than similar foods that are not GM.						
US	20.0	24.8	34.6	16.3	4.4	
Norway	33.6	31.0	19.5	6.9	9.2	0.00
I am willing to pay at least 10% more for foods that are produced in a sustainable way.						
US	8.7	19.6	43.5	25.2	3.1	
Norway	6.6	15.1	44.6	29.8	4.0	0.00
I am willing to consume genetically modified foods if that reduces the use of pesticides.						
US	16.2	21.7	37.3	20.6	4.2	
Norway	20.5	24.1	32.9	11.3	11.2	0.00
I frequently read the nutritional labeling on food products before I buy them.						
US	7.4	16.4	32.4	42.5	1.5	
Norway	9.3	20.5	37.0	32.3	0.9	0.00
It is important that genetically modified food products are labeled as such.						
US	3.5	7.0	29.6	57.2	2.6	
Norway	2.0	3.3	14.9	77.2	2.6	0.00

Notes: [a] Based on 1,026 respondents in the US and 1,037 in Norway. [b] The p-value for a non-parametric Kruskall-Wallis test for whether samples originate from the same distribution.

Third, with the exception of Chern et al. (2002), no other studies have, to our knowledge, examined and compared consumers' preferences and valuation for a GM-fed product, a GM plant product for human consumption, and a GM animal for human consumption.

Data and Survey Results

Data were collected from an online survey conducted between October and November of 2015 in Norway and the United States. The sample consists of 1,037 Norwegian and 1,026 US respondents. Respondents were randomly recruited across regions/states and urban/non-urban areas in both countries by the market research agency Ipsos.[1] Respondents were invited to participate in an internet survey and were asked about the aspects they considered more or less important when buying food products. They were assured that any given information will remain anonymous and that they could quit the survey whenever they wanted to. The survey also contained some questions about attitudes and WTP to avoid GM alternatives.

Table 2 shows the distribution of answers regarding some important attitudes. We used a response scale from "totally disagree" to "totally agree" but also included an "impossible to answer" response alternative, and between 0.8% and 12.1% of the respondents responded by using this option on the different questions. We will use the term "support" for respondents who responded that they either "somewhat agreed" or "totally agreed" to the various attitudinal questions.

One may expect that respondents who find food to be expensive are less willing to pay more for conventional than GM food. More than 75% of the US respondents supported the claim that food is expensive while slightly more than 60% of the Norwegian respondents

1. *See http://ipsos-mmi.no/.*

supported this claim. This difference may be somewhat surprising given very high Norwegian food prices. However, as discussed in Bazzani, Gustavsen, Nayga, Jr., and Rickertsen (2017), it may be a reflection of the more equal income distribution with relatively few low-income households in Norway.

About 63% of the US and 55% of the Norwegian respondents supported the statement that it is important to utilize biotechnology to create improved plants and animals, while about a third in both countries did not support it. This skepticism is less than the skepticism expressed in the Eurobarometer surveys on biotechnology. Here, Europeans have been found to view GM food as risky, not useful, and not morally acceptable and a majority disagreed with the idea that the development of GM food should be encouraged (European Commission, 2010).

Furthermore, more than 85% of the respondents in both countries supported the claim that the nutritional content is important when they buy food. However, they are skeptical towards consuming GM foods even when they are more nutritious than conventional foods, with only about half the US and a quarter of the Norwegian respondents agreeing that they would consume GM foods if they are more nutritious than conventional foods. This is lower than the results reported in Chern et al. (2002), who used a similar question and found that more than 70% of the US and more than 35% of the Norwegian respondents stated that they were willing to consume such foods. Consumer acceptance of nutritionally enhanced GM foods, however, can be influenced by the nature of the gene-transfer technology being used to increase the nutritional content of GM foods (Onyango & Nayga, Jr., 2004).

More than two-thirds of the US respondents and about 75% of the Norwegian respondents supported the claim that they would pay 10% more for foods that are produced in a sustainable way. However, only 58% of the US and 44% of the Norwegian respondents supported the claim "I am willing to consume genetically modified foods if that reduces the use of pesticides." This is a somewhat higher percentage for the United States and a somewhat lower percentage for Norway than the answers reported in Chern et al. (2002), who used a similar question and found that close to 70% of US respondents and close to 40% of Norwegian respondents were willing to do so. These results may reflect the trade-off between product benefits and potential risks in consumer acceptance of GM foods (Onyango, Nayga, Jr., & Schilling, 2004).

The food-label use in both countries is high. Close to 75% of the US and close to 70% of the Norwegian respondents supported the claim that they frequently read nutritional labeling on food products. This is consistent with results in previous studies (e.g., Drichoutis, Lazaridis, & Nayga, Jr., 2012; Petrovici, Fearne, Nayga Jr., & Drolias, 2012). There is also a strong support to GM labeling in both countries, with 87% of the US and 92% of the Norwegian respondents supporting the importance of labeling GM food products as such. These results reflect very small changes in attitudes towards GM labeling as compared with Chern et al. (2002). They used a similar question and found that 87% of their US respondents and 99% of the Norwegian ones somewhat or extremely agreed to a similar question.

The respondents were asked about their WTP for salmon fed with GM soybeans, GM soybean oil, and GM salmon; i.e., an animal that has been eating GM feed, a GM plant for direct human consumption, and a GM animal for direct human consumption. They were asked about their WTP for the conventional alternative as compared with the GM alternative by indicating their maximum WTP on a multiple price list with the following alternatives: "nothing, will not pay more," "a maximum of 20% more," "21-50% more," and "do not know."[2]

The distribution of the WTP to avoid the GM alternatives is shown in Table 3. About 40-50% of the respondents indicated that they would not pay any premium for the conventional alternatives. Only between 7 and 13% of the respondents indicated that they were willing to pay more than 20% extra. Furthermore, the distributions in WTP for the two countries are quite similar. The largest difference is for the GM salmon. More than half the US and less than 40% of the Norwegian

2. *The three questions used were: (1) Imagine that you are purchasing soybean oil. The store has two types of oil. The first is made from non-genetically modified soy and the other is made from genetically modified soy. How much more are you willing to pay for the non-genetically modified oil as compared with the genetically modified oil? (2) Imagine that you are purchasing salmon. The store has two types of salmon. Non-genetically modified soy has been a part of the feed of the first type of salmon and genetically modified soy has been a part of the feed of the other type. How much more are you willing to pay for the salmon that has been fed non-genetically modified soy? (3) Imagine a genetically modified salmon has been developed. The store has conventional farmed salmon and the genetically modified salmon. How much more are you willing to pay for conventional salmon?*

Table 3. Willingness to pay to avoid GM alternatives, percentage distributions.[a]

	GM soybean oil		GM-fed salmon		GM salmon	
Premium	**US**	**Norway**	**US**	**Norway**	**US**	**Norway**
Nothing	48.4	43.8	47.0	44.6	51.1	38.6
Max. of 20% more	28.9	28.8	28.2	31.2	26.0	36.3
21-50% more	7.9	4.4	10.3	5.1	7.5	6.7
More than 50% more	2.8	3.1	3.0	2.2	5.7	3.8
Do not know	11.9	19.9	11.4	16.8	9.7	14.8
p-value[b]		0.00		0.00		0.00

Notes: [a] Based on 1,026 respondents in the US and 1,037 in Norway. [b] The p-value for a non-parametric Kruskall-Wallis test for whether samples originate from the same distribution.

Table 4. Summary statistics for the explanatory variables.

		United States		Norway	
Variable	**Definition**	**Mean**	**S.D.**	**Mean**	**S.D.**
Age	Age of respondent in years	40.45	12.69	53.93	15.02
Income	Log of household's income[a]	3.89	0.72	6.16	0.81
Male	= 1 if male	0.52	0.49	0.52	0.49
Education	= 1 if completed Bachelor or similar	0.55	0.50	0.64	0.48
Married	= 1 if married or cohabitant	0.57	0.49	0.71	0.45
Children	= 1 if children aged 18 years or less live in the household	0.44	0.49	0.30	0.46
Farm	= 1 respondent live or has lived on a farm	0.35	0.48	0.28	0.45
City	= 1 if lives in a city with more than 100,000 inhabitants	0.43	0.49	0.29	0.45
Q1	= 1 if totally or somewhat agreed to question 1[b]	0.53	0.49	0.28	0.45
Q2	= 1 if totally or somewhat agreed to question 2[c]	0.59	0.49	0.45	0.49
Q3	= 1 if answered "very important" to question 3[d]	0.40	0.49	0.44	0.49
n	Number of observations	824		746	

Notes: [a] The income was divided in nine income groups, and the respondent's income was set to the midpoint of the income group. For the highest and lowest income, the censoring point was set as the income. Income was measured in US$ in the United States and in NOK in Norway.

[b] Question 1: I am willing to consume genetically modified foods if they were more nutritious than similar foods that are not genetically modified (the alternatives were: totally disagree, somewhat disagree, somewhat agree, totally agree, and impossible to answer).

[c] Question 2: I am willing to consume genetically modified foods if that reduces the use of pesticides in agriculture (the alternatives were: totally disagree, somewhat disagree, somewhat agree, totally agree, and impossible to answer).

[d] Question 3: The foods that we consume have many attributes. How important is "Naturalness" (defined as: made without modern food technologies like genetic engineering, hormone treatment and food irradiation) to you? (The alternatives were: very important, somewhat important, and not important).

respondents would not pay anything extra for a conventional farmed salmon as compared with the GM salmon. We may also note that there are small differences in the distribution of WTP across the products. Between 10 and 20% of the respondents chose the "do not know" response alternative.

To estimate the WTP, we deleted the respondents who had chosen the "do not know" response alternative for at least one of the products, and included the variables shown in Table 4. The estimation sample consisted of 824 respondents in the United States and 746 in Norway. The average age of the respondents was substantially higher in Norway (54 years) than in the United States (40 years). Gender distribution was similar in both samples, with about 52% male respondents in both countries. More Norwegian respondents than US respondents (64% and 55%), respectively, had completed a Bachelor degree or similar. The Norwegian sample was also characterized by a higher percentage of married people and cohabitants (71%) in comparison to the US sample (57%). On the other hand, respondents in the United States had more children in the household;

however, most respondents in both countries indicated having no children in their household (70% for Norway and 56% for the United States). More US respondents than Norwegian respondents live or have lived on a farm (35% and 28%) and live in a city with more than 100,000 inhabitants (43% and 29%).[3]

We also included the answers to the three questions shown in the notes to Table 4 related to respondents' attitudes towards GMOs. More US than Norwegian respondents indicated that they were willing to consume GM foods if they were more nutritious (53% and 28%) or reduced the use of pesticides (59% and 45%). Myskja (2006) found that one of the main concerns related to GM food is the concept of naturalness and the fact that GM foods are seen as "unnatural" by European consumers. Slightly more Norwegian than US respondents found the attribute "naturalness" to be very important (44% and 40%).

Econometric Model

Based on the responses from the multiple price list, we estimated the WTP for the intervals shown in Table 3 using an interval regression model. This model is a generalization of the Tobit model when we have known intervals (Amemiya, 1973). For each product, the respondents who are not willing to pay more for the conventional alternative are in the zero block. The respondents who are willing to pay a maximum of 20% more are in the interval from [1,20], the respondents who are willing to pay 21-50% more are in the interval [21,50], and the respondents who are willing to pay more than 50% are censored at 51. We assume that the underlying outcome variable is normally distributed, and the likelihood function for WTP for each product is

$$L = \prod_{WTP=0} \Phi\left[\frac{x_i'\beta}{\sigma}\right] \prod_{0<WTP\leq 20}\left(\Phi\left[\frac{20-x_i'\beta}{\sigma}\right]-\Phi\left[\frac{1-x_i'\beta}{\sigma}\right]\right) \prod_{21<WTP\leq 50}\left(\Phi\left[\frac{50-x_i'\beta}{\sigma}\right]-\Phi\left[\frac{21-x_i'\beta}{\sigma}\right]\right)\prod_{51<WTP}\left(1-\Phi\left[\frac{51-x_i'\beta}{\sigma}\right]\right), \quad (1)$$

where Φ is the cumulative distribution function for the standard normal, σ is the standard error of WTP, $\boldsymbol{\beta}$ is a vector of parameters, and $\boldsymbol{x}$ is a vector of variables.

Given that our data have a panel structure with a high potential correlation between each respondent's WTP values for the three products, we used the xtintreg procedure in Stata to estimate the model (Stata, 2013). This procedure allows for covariances between the error terms of the three equations representing the three products. The latent willingness to pay, WTP^*, is estimated as

$$WTP^*_{ij} = W_1 x'_{ij}\beta_1 + W_2 x'_{ij}\beta_2 + W_3 x'_{ij}\beta_3 + v_i + e_{ij}, \quad (2)$$

where $\boldsymbol{x}_{ij}$ is a vector of explanatory variables, j denotes the three products, i =1, …n denotes the respondents, W_1=1 for the first product and 0 otherwise, W_2=1 for the second product and 0 otherwise, and W_3=1 for the third product and 0 otherwise. These dummy variables allow for different marginal effects on the different products. The error term v_i represents respondent specific random variation that is assumed iid $N(0, \sigma^2_v)$ and the error term e_{ij} is an observation specific error term that is assumed to be independent of v_i and $N(0, \sigma^2_e)$. In the likelihood function given by Equation 1, $x'_i\beta$ is replaced by $W_1x'_{ij}\beta_1 + W_2x'_{ij}\beta_2 + W_3x'_{ij}\beta_3$. The proportion of the total variance contributed by the panel-level variance component is given by

$$\rho = \frac{\sigma_v^2}{\sigma_e^2 + \sigma_v^2}. \quad (3)$$

When ρ is zero, the panel-level variance component is unimportant, and the panel estimator is not different from the pooled estimator. If ρ is high, the respondent specific variation is high and the panel structure is important.

Estimation Results and Discussion

The estimated parameters in Table 5 represent the marginal effects of the independent variables on the WTP for the conventional as compared with the GM alternative of each product. The parameters that are significant at the 5% level of significance are printed in bold. The results of the unrestricted model where all the parameters are allowed to be different for the different products are presented in four of the columns in the table. The unrestricted model has many insignificant parameters in both countries. To reduce the number of parameters, we tested a model with identical marginal effects and only

3. *The income distribution in the full sample including the respondents who answered "do not know" to some of the WTP questions shows that the majority of the respondents in the United States had an annual income below $59,000 (56%), while only 23% of the Norwegian sample had an annual income below $62,400. Importantly though, the income differences are calculated at market exchange rates that vary considerably over time and are quite different from the exchange rates calculated at rates that reflect the purchasing power.*

Table 5. Parameter estimates and t-values for unrestricted and restricted models.

	United States				Norway			
	Unrestricted		Restricted		Unrestricted		Restricted	
Variable	Parameter	t-value[a]	Parameter[b]	t-value	Parameter	t-value	Parameter	t-value
GM soybean oil								
Constant	**6.78**	2.03	**7.80**	2.93	-2.85	-0.71	-1.76	-0.47
Age	**-0.23**	-5.74	**-0.24**	-7.12	0.02	0.66	-0.01	-0.31
Income	0.89	1.11	1.16	1.66	1.22	1.95	**1.36**	2.35
Male	**2.49**	2.52	**1.84**	2.13	**-2.04**	-2.10	-1.23	-1.36
Education	-0.01	-0.01	-0.15	-0.16	**3.16**	3.15	**2.75**	2.96
Married	0.42	0.38	0.27	0.28	-0.23	-0.18	-0.71	-0.61
Children	**2.73**	2.61	**2.20**	2.41	0.08	0.07	-0.17	-0.17
Farm	-1.24	-1.20	-1.39	-1.54	-0.84	-0.68	-0.96	-0.84
City	1.17	1.20	1.62	1.91	0.00	0.00	-0.06	-0.06
Q1	1.59	1.28	**2.19**	2.03	-2.61	-1.94	**-3.42**	-2.75
Q2	1.04	0.83	0.04	0.04	-1.44	-1.20	-0.93	-0.84
Q3	**6.79**	6.58	**5.67**	6.31	**5.89**	5.63	**6.03**	6.23
GM-fed salmon								
Constant	**7.34**	2.19	**8.46**	2.93	-1.84	-0.46	-1.86	-0.49
Age	**-0.24**	-6.14			-0.02	-0.63		
Income	**1.59**	1.98			**1.46**	2.35		
Male	1.63	1.64			-0.82	-0.84		
Education	-0.14	-0.13			**2.42**	2.41		
Married	-0.54	-0.48			-0.49	-0.39		
Children	**2.30**	2.19			-0.56	-0.51		
Farm	-1.54	-1.50			-0.86	-0.70		
City	1.36	1.40			-0.11	-0.10		
Q1	1.51	1.22			**-3.58**	-2.67		
Q2	0.52	0.42			-0.63	-0.53		
Q3	**5.84**	5.64			**5.59**	5.32		
GM salmon								
Constant	**11.03**	3.30	**8.83**	2.93	0.96	0.24	-0.23	-0.06
Age	**-0.27**	-6.83			-0.03	-0.97		
Income	0.98	1.22			**1.39**	2.23		
Male	1.39	1.41			-0.76	-0.77		
Education	-0.26	-0.24			**2.70**	2.68		
Married	0.98	0.88			-1.43	-1.12		
Children	1.58	1.52			-0.04	-0.04		
Farm	-1.39	-1.35			-1.15	-0.93		
City	**2.33**	2.39			-0.11	-0.10		
Q1	**3.45**	2.80			**-4.12**	-3.05		
Q2	-1.39	-1.12			0.70	-0.58		
Q3	**4.40**	4.28			**6.65**	6.31		
Logl value	-6,123		-6,135		-4,813		-4,823	
AIC	12,322		12,303		9,701		9,678	
BIC	12,543		12,396		9,918		9,770	
ρ[c]	0.69		0.68		0.83		0.83	
p LR-test[d]			0.32				0.50	
n	2,472		2,472		2,238		2,238	

Notes: [a] Critical value for significance at the 5% level is 1.96. Significant parameter estimates are printed in bold. [b] Equal marginal effects are imposed on all parameters except for the constants. [c] ρ is the panel level variance. [d] p LR-test is the p-value of a likelihood-ratio test for parameter equality in the restricted models.

Table 6. Estimated WTP to avoid GM alternatives, percentage premiums.

	United States		Norway	
Product	**Unrestricted**	**Restricted**	**Unrestricted**	**Restricted**
Soybean oil	8.14 (0.50)[a]	8.12 (0.62)	7.68 (1.65)	7.66 (1.73)
Soybean-fed salmon	8.78 (0.53)	8.78 (0.63)	7.52 (1.66)	7.56 (1.73)
Salmon	9.15 (0.55)	9.15 (0.70)	9.21 (1.63)	9.20 (1.72)

Note: [a] Standard deviations in parentheses

alternative specific parameters by using a likelihood-ratio test. This restricted model was not rejected neither for the US (*p*-value=0.32) nor for Norway version (*p*-value=0.50). The results of the restricted models are presented in four of the columns of Table 5.[4]

The parameter estimates of the restricted and unrestricted models are—as expected—quite similar, and so we focus our discussion below on the results of the restricted models. The parameters associated with the constant can be interpreted as the WTP for a hypothetical (and nonexistent) reference respondent who has no income and is zero years old. These alternative specific constants are significant for the United States but insignificant for Norway.

Attitudes are important, and respondents who believe it is very important that the foods are "natural" (defined as foods made without modern food technologies like genetic engineering, hormone treatment, and food irradiation) are willing to pay substantially more for the conventional alternatives than the GM alternatives in both countries. Results shown in Table 5 indicate that these premiums are 5.7% in the US and 6.0% in Norway. The marginal effects of being willing to consume GM foods that have nutritional benefits have the opposite signs in the two countries. It reduces the WTP for the conventional alternatives among Norwegian respondents by 3.4%. Interestingly, in the US, it increases the WTP for the conventional alternatives by 2.2%. Finally, respondents who claim to be willing to consume GM foods if that reduces the use of pesticides are not willing to pay any additional premium for the conventional form of any product in either country.

The effects of socioeconomic variables differ quite a bit between the countries. The age effect is negative and significant in the US. If age increases by one year, a US respondent is willing to pay 0.2% less for the conventional alternatives. In Norway, the age effects are insignificant, which may be due to an older sample. The gender effect is only significant for the United States where a male is willing to pay 1.8% more than a female for the conventional products. The presence of children increases the WTP for the conventional alternatives in the United States by 2.2%. The presence of children has no significant effects in Norway, which again may be due to the older sample. Income and education are significant in Norway but insignificant in the United States. If income increases by 1% in Norway, the respondent would be willing to pay 1.4% more for the conventional alternatives. The WTP increases by 2.8% for the conventional alternatives among Norwegian respondents who have completed a Bachelor degree or similar.

The WTP premium for each respondent and equation was predicted by the estimated models, and the average premium for each equation was calculated. These average percentage premiums for the conventional alternatives are presented in Table 6. The premiums range from 7.5% to 9.2% and all the premiums are significantly different from zero at the 5% level of significance. The similarity in premiums in the two countries suggests that the US and Norwegian respondents are willing to pay more or less the same premiums for the conventional alternatives regardless of the product. These results have several interesting implications.

First, the WTP estimates are, in general, relatively low as compared with the results reported in Chern et al. (2002). Specifically, they found that their US and Norwegian respondents were willing to pay premiums that sometimes exceeded 50% for conventional soybean oil and salmon. The reduced premiums in our study may reflect increased familiarity with GM foods over time. They also seem to be more realistic given the relative success of GM foods in many markets. The results also seem to corroborate the results in some other recent studies. For example, a study conducted by Aerni,

4. The estimated ρ is quite high (0.69 and 0.68 for the US models and 0.83 for the Norwegian models), which suggests that the panel structure is important. A likelihood-ratio test for identical parameters in the two countries clearly rejected identical parameters (p-value=0.00).

Scholderer, and Ermen (2011) in Switzerland showed that consumers treated GM foods just like any other type of novel food. More recently, Delwaide et al. (2015) asked their European respondents if they would be willing to consume a GM food product if it were available. Interestingly, they found that the proportion of consumers not willing to consume a GM food product was approximately only 10% of the participants in Belgium, 31% in France, 15% in the Netherlands, 11% in Spain, and 15% in the United Kingdom.

Second, there are no substantial differences between the WTP in the United States—where they have been consuming GM food for 20 years—and Norway—where there has been no such consumption. The equality in WTP indicates a convergence, in contrast to the results reported in Chern et al. (2002), who found that Norwegian respondents were willing to pay a higher premium (54%) than US respondents (41%) for conventional salmon as compared to GM-fed salmon, as well as for conventional salmon as compared to GM salmon (67% and 54%).

Third, our respondents do not have a very different WTP for a GM plant as compared to an animal who has been eating GM feed, or a GM animal. As mentioned above, Chern et al. (2002) found differences of more than 10 percentage points in both countries between GM-fed salmon and GM salmon.

While the results discussed above are interesting and important, there are some limitations of our study that need to be noted. First, the results are based on a survey without any real economic incentives for the respondents to answer truthfully. In such a hypothetical setting, respondents may be more willing to spend their money than in a real setting. For a meta-analysis of the hypothetical bias problem, see List and Gallet (2001).

Second, as discussed above, the average age of the Norwegian respondents was quite high, which may have reduced the marginal effects of age and presence of children. If there is a large age component in the WTP for GM products, the WTP results could also be less representative for the population. However, the age effects were small in the Norwegian sample.

Third, the survey questions and elicitation procedure may have affected the outcome. Our elicitation procedure involved a MPL with only a few broad intervals, and different procedures could have resulted in different estimates. The order of the three WTP questions was identical for all the respondents: GM soybean oil, GM-fed salmon, and GM salmon. This could potentially result in some ordering effects with an anchoring to the first response regarding the WTP for soybean oil. Furthermore, the respondents had no alternative to express a positive WTP for the GM alternatives.

Conclusions

There are strong attitudes towards GM foods in many parts of the world and the strong attitudes are also reflected in this study. About 63% of US and 55% of Norwegian respondents believe it is important to utilize biotechnology to create improved plants and animals. However, only about half the US and a quarter of the Norwegian respondents claimed to be totally or somewhat willing to consume GM foods if they were more nutritious than similar conventional foods. Furthermore, 58% of the US respondents and 44% of the Norwegian respondents were totally or somewhat willing to consume GM food if that reduces the use of pesticides.

The differences in WTP for the conventional as compared with the GM alternatives appear to be smaller than one could expect from the expressed attitudes. Only between 7 and 13% of respondents in the United States and Norway, respectively, indicated that they were willing to pay more than 20% extra for a conventional as compared to a GM alternative. The average estimated WTP premiums range from 7.5 to 9.2%. This suggests that there is a large similarity in WTP in Norway and the United States and across the three types of food. Furthermore, the premiums seem to be more realistic than other survey values that frequently have been reported and could suggest a market for such products also in Europe.

The results generally indicate a strong support for GM labeling in both countries given that around 90% of the respondents in each country supported the statement that it is important that GM food products are labeled as such.

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