Food Values, Personality Traits, and Attitudes towards Genetically Modified Food in Norway and the United States

Aida T. Ardebili*
Associate Professor, Norwegian University of Life Sciences, School of Economics and Business, P.O. Box 5003, N-1432 Ås, Norway
Email: aida.ardebili@nmbu.no
Orcid Id: https://orcid.org/0000-0001-5786-3518

Kyrre Rickertsen
Professor, Norwegian University of Life Sciences, School of Economics and Business, P.O. Box 5003, N-1432 Ås, Norway
Email: kyrre.rickertsen@nmbu.no
Orcid Id: https://orcid.org/0000-0002-5068-0847

We explored the effects of personality traits and subjective beliefs on willingness to pay (WTP) to avoid genetically modified (GM) foods using a random effects interval regression model. The personality traits were measured by the Big Five model, and the subjective beliefs were measured by a set of food values. We used data from an online survey conducted in Norway and the US. The effects of sociodemographic factors and personality traits are country specific. Most of the food values are significant in both countries. GM aversion is associated with believing that GM products are unnatural with possible negative impacts on the environment and animal welfare and unfair to farmers, processors, and retailers. Public information could focus on the potential benefits of adopting this technology for reduced pesticide use in agriculture. Adopting more liberal policies towards GM foods might also reduce the safety concerns among European consumers.

Key words: Big Five, beliefs, consumer preferences, food values, genetic modification, personality traits, salmon.

1. Introduction

The concerns about genetically modified (GM) foods are frequently associated with risk perceptions that are not based on scientific results. Nevertheless, there is no agreement on why such concerns have persisted for so long towards a technology that is as safe as conventional breeding technologies (World Health Organization, 2014). Lusk et al. (2014a) pointed out that the literature has focused more on measuring individuals' preferences or valuations of GM foods than on measuring beliefs, while findings suggest that a priori beliefs are among the most important determinants of attitudes towards GM foods (Dixon, 2016; Lusk et al., 2004). Earlier studies attributed the negative attitudes towards GM foods to perceived unnaturalness and perceived negative health or environmental consequences from consumption of these products (Costa-Font et al., 2008). However, consumers' perceptions may have changed given recent advancements in GM technologies. Traditional genetic modification altered the genetic makeup of an animal or a plant by transferring a piece of DNA from one organism to another. The CRISPR/Cas genome editing technique was introduced in 2012 (Jinek et al., 2012). This technology has the potential to revolutionize plant and animal breeding and develop new products without inserting foreign DNA.[1] This ability coupled with a very high degree of precision may have reduced consumer opposition against GM products (Bartkowski et al., 2018).

Established theories in consumer research such as the expectancy-value theory (Fishbein & Ajzen, 1977), the means-end chain model (Gutman, 1982), and the theory of planned behavior (Ajzen, 1985), emphasize the importance of beliefs in consumers' decision-making process. According to these theories, values and beliefs form the consumers' attitudes and perceptions about different product attributes. Food-related beliefs may be reflected by food values. Food values refer to a set of food specific meta preferences and were developed by Lusk and Briggeman (2009). They suggested 11 food values that were likely to be relatively stable over time and could explain consumers' food choices across a wide range of food products. These values are naturalness, taste, price, safety, convenience, nutrition, tradition, origin, fairness, appearance, and environmental impacts. The external validity of these food values has been demonstrated by using actual grocery store purchases (Lusk, 2011b). Their relative importance has been found to be quite stable over time (Tonsor et al., 2018), and to represent a more permanent component of individuals' preferences for food (Lusk, 2011a; Lusk & Briggeman, 2009). For example, consumers' preferences for GM foods may change as their perceptions about the safety of GM foods change, while their preferences and the relative importance assigned to the value food safety remain quite stable over time.

Many food-related decisions are made unconsciously. Therefore, conceptual models of food-related behavior refer to individuals' psychological characteristics as one of the influential factors in determining food choices (Furst et al., 1996; Köster, 2009). Accounting for individuals' characteristics such as psychological factors may improve the understanding of preference heterogeneity in general and choice patterns for foods in particular (Bazzani et al., 2017).

Personality is defined as: "relatively enduring patterns of thoughts, feelings, and behavior that reflect the tendency to respond in certain ways under certain circumstances" (Roberts, 2009). The Big Five personality traits (Goldberg, 1981) is one of the most frequently used models to measure and classify personality traits into five broad dimensions: openness to experiences, conscientiousness, extraversion, agreeableness, neuroticism (OCEAN). The OCEAN traits have been found to be relatively stable over time and represent enduring coherence of behaviors (Cobb-Clark & Schurer, 2012).

[1] It should be noted that no distinction between conventional GM and the CRISPR/Cas technology was made in the survey used in this paper. However, general media attention may still have influenced the respondents.

Norway and the US differ in several aspects of their food systems including the regulation on GM foods. Import, production, and sales of GM foods or food with GM ingredients are banned in Norway while these products are widely available in the US. Moreover, Bazzani et al. (2018) found some differences in the importance ranking of food values between these two countries. Finally, there are some important socioeconomic differences between the countries related to income distribution, provisions of public financed education and health care. For all these reasons, it is interesting to compare the perceptions about GM foods in Norway and the US, while taking socioeconomic and psychological factors into account.

Attitudes towards a food product may be reflected by the willingness to pay (WTP) for the product. As discussed above, a priori beliefs are among the important determinants of the attitudes towards GM foods, and they may be reflected by associations between food values and attitudes towards GM foods. However, to our knowledge, the effects of food values on WTP for GM foods have not been investigated. Moreover, only two studies have investigated the effects of the OCEAN traits on WTP for GM foods (Ardebili & Rickertsen, 2020; Lin et al., 2019). The data were collected in an online survey in Norway and the US in 2015, which included three GM foods: GM soybean oil (plant-based food), GM-fed salmon (an animal fed with GM feed), and GM salmon (an animal). The same data set was used by Rickersten et al. (2017) and Bazzani et al. (2018). However, neither of these studies investigated the effects of personality traits; Rickersten et al. (2017) did not investigate the effects of food values, and Bazzani et al. (2018) did not investigate WTP.

2. Literature Review

We will briefly present some recent results related to: (i) effects of food values on consumer preferences for food, (ii) effects of the OCEAN traits on preferences for food and specifically GM foods, (iii) effects of knowledge, beliefs, and labeling on preferences for GM foods, and (iv) WTP values for GM foods.

2.1. Food Values

Food values have been associated with preferences and demand for food. Lusk and Briggeman (2009) found that the price was negatively associated with higher WTP for organic bread, while nutrition, naturalness, environmental impact, and origin were positively associated. Lusk (2011b) used scanner data and discrete choice demand model and found that environmental impact and tradition were associated with higher demand for organic eggs and milk, while price and convenience were associated with lower demand. Tonsor et al. (2018) used US survey data over a four-year period and regression analysis and found that animal welfare, nutrition, environment, and naturalness were negatively associated with the demand for beef steak and ground beef. Taste, appearance, and novelty were positively associated while safety was unimportant for both products. In an Italian experimental auction, Pappalardo and Lusk (2016) used ordinary least squares and found that the WTP for functional foods were positively associated with the food value health. However, after tasting the foods, safety and taste were associated with lower WTP.

Bazzani et al. (2018) used a multinomial logit and a mixed logit model to compare the relative importance of food values in the US and Norway with the data set used in this study. They found that food safety was most important in both countries, which is in line with the results reported in Lusk and Briggeman (2009) for the US, who used the same data analysis technique. They also found that the price was ranked quite differently in the two countries. Price was ranked as the second most important value in the US and only the sixth most important in Norway.

2.2. OCEAN Traits

Many recent studies have found that the OCEAN traits are associated with food choices and food-related attitudes or preferences. Gustavsen and Hegnes (2020a, 2020b) used a binary logistic regression model and found that openness to experience was positively related to the attitudes towards organic food and local food; Ufer et al. (2019) used a Tobit model and found that extraversion and conscientiousness increased preferences for cooperative-grown coffee; Gustavsen and Rickertsen (2019) used a beta regression model and found that agreeableness was negatively, and extraversion and openness to experience were positively associated with consumption frequency of wine; and Nezlek and Forestell (2019) used multiple regression analysis and found that openness to experience was associated with less food neophobia. Several studies have found that neuroticism is negatively and openness to experience, conscientiousness, and agreeableness are positively related to healthier dietary patterns, better self-rated health, and lower BMI (Pfeiler & Egloff, 2020; Weston et al., 2020). A recent review of associations between the OCEAN traits and food choices and consumption is provided by Machado-Oliveira et al. (2020).

The OCEAN traits have been included in some studies about preferences for labeling of GM foods and WTP and risk perceptions about such foods. Peschel et al. (2019) used a latent class model and found that openness to experience and neuroticism were associated with preferences for production method labeling such as GM-free and pesticide free labeling of dates in the US. DeLong and Grebitus (2018) used a bivariate ordered probit model and found that conscientious individuals were more likely to desire labelling of GM sugar and soft drinks with GM sugar contents in the US. Lin et al. (2019) estimated a mixed logit model and found that openness to experience increased WTP for GM pork in Italy, China, and the US, while conscientiousness decreased this WTP in Italy and the US, but not in China. They also found that extraversion was positively, and agreeableness was negatively associated with WTP for GM pork in the US. Ardebili and Rickertsen (2020) used random effect interval regression analysis and found that higher score of conscientiousness decreased the WTP to avoid GM-fed and GM salmon in Norway, while higher score of agreeableness increased the premiums to avoid these products. Whittingham et al.

(2020) used communication data from Twitter accounts and lexical analysis to obtain information regarding users' perception about the safety of GM foods and to predict the score of their personality traits and values. Logistic regression analysis suggested that higher score on extraversion was positively associated with the perception that GM foods is unsafe, while higher scores of openness to experience, agreeableness, and neuroticism were negatively associated with this perception. Moreover, they found that self-transcendence values such as universalism and benevolence were associated with the perception that GM foods is unsafe.

2.3. Knowledge, Beliefs, and Labeling

Consumers' preferences and attitudes towards GM foods have been investigated from different perspectives over the last two decades, and there are several reviews (Costa-Font et al., 2008; Frewer et al., 2013; Scott et al., 2018; Wunderlich & Gatto, 2015). House et al. (2004) differentiated between consumers' objective and subjective knowledge. Their results indicate that subjective knowledge is a significant determinant of consumers' willingness to accept GM foods, whereas objective knowledge is unrelated to acceptance of these products.

Several recent studies have focused on the effects of knowledge or beliefs on GM aversion and found that subjective knowledge and beliefs are important for attitudes towards GM products. Nunez et al. (2016) used a survey experiment and found that science and genetic literacy may influence perceptions about GM foods and increase the desirability of these products. Fernbach et al. (2019) used ordinary least squares on data from the US, France, and Germany, and showed that the extreme opponents of GM foods were those who knew the least about genetics but perceived themselves to be knowledgeable. McFadden and Lusk (2016) also found that US consumers overestimated their own level of knowledge about GM foods. Dixon (2016) used ordinary least squares and found that information had little effect on individuals with negative beliefs about GM foods. Ortega et al. (2020) used a mixed logit model and found that consumers were most responsive to information treatments when they were most uncertain about their preferences for GM pork. Ardebili and Rickertsen (2020) used random effect interval regression analysis and found that Norwegians who lacked information about domestic restrictions on the use of genetic engineering had more positive attitudes towards GM foods. Some studies have also suggested that labeling will create negative perceptions about GM products (Lefebvre et al., 2019). However, Kolodinsky and Lusk (2018) used difference-in-difference estimates of GM aversion and found that opposition to GM foods dropped by 19% after mandatory labeling was implemented in the state of Vermont.

2.4. WTP for GM Foods

Numerous studies have estimated the WTP premiums to avoid GM foods or valuation of such products, and reviews are provided by Colson and Rousu (2013), Dannenberg (2009), and Lusk et al. (2005). A meta-analysis by Hess et al. (2016) included 214 studies. Quite interestingly they found that consumers' evaluations of GM foods did not depend on the type of food, and EU consumers were not more GM averse than consumers in other countries when negative and positive connotations of the questions were controlled for. Not surprisingly, more positively framed questions were associated with more positive evaluations of GM foods. The effect of samples is demonstrated by two studies using Norwegian samples. Rickersten et al. (2017) used random effect interval regression analysis and found average premiums of 7-9% to avoid GM soybean oil, GM-fed salmon, and GM salmon in Norway, while Ardebili and Rickertsen (2020) found twice as high premiums for the same products using a different Norwegian sample with data collected close in time and using the same valuation questions. An example on large country specific effects is Lin et al. (2019) who used a mixed logit model with utilities specified in WTP-space and found that US, Chinese, and Italian respondents asked for discounts of around 40%, 80%, and more than 280% per pound of GM pork, respectively. Whereas Vermeulen et al. (2020) used logistic regressions and found that South African pro-GM consumers were willing to pay a premium of 8.7% for sugar derived from genetically modified sugarcane.

As mentioned above, this is the first study that investigates the associations between food values and attitudes towards genetically modified (GM) foods. Given the importance of consumers' a priori beliefs in determining their attitudes towards GM foods, it is of particular interest to investigate such associations in models where personality traits and sociodemographic characteristics also are accounted for.

3. Materials and Methods

3.1. The Survey

An online survey was conducted between October and November 2015 in Norway and the US. Data were collected by a market research agency (Ipsos), who randomly recruited respondents across regions in both countries.[2] More than one thousand respondents participated in each country (1,037 in Norway and 1,026 in the US). The respondents could quit the survey whenever they wanted and were assured that their information was anonymous. The survey included a choice experiment on food values and questions about sociodemographic factors, attitudes, and personality traits. As discussed in more detail in Bazzani et al. (2018), the samples were relatively representative of the national populations in terms of sociodemographic characteristics with two exceptions. The average age of the Norwegian sample was higher than the population, and the samples in both countries were more educated than their respective country populations.

3.2. Measurements of Variables and Descriptive Statistics

The WTP values to avoid GM products were based on the respondents' answers to three questions: (1) "Imagine that

[2] More information can be found in https://www.ipsos.com/nb-no/samfunnsundersokelsen-norsk-monitor

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?". The respondents could choose one of the following alternatives "nothing, will not pay more", "a maximum of 20% more", "21-50% more", "more than 50% more", and "do not know".

Table 1 presents the percentage distributions of the WTP values to avoid the three GM alternatives in Norway and the US. The last row of the table reports the *p*-values of a Kruskall-Wallis test for whether the samples originate from the same distribution. We can reject identical distributions of WTP values for GM salmon, but not for GM soybean oil and GM-fed salmon. Following Rickersten et al. (2017), we removed all respondents who chose the 'do not know' alternative for at least one good, and 291 Norwegian observations and 202 US observations were removed. The subsequent descriptive statistics and analyses are therefore based on 746 Norwegian and 824 US observations.

Table 1. Willingness to Pay to Avoid GM Alternatives, Percentage Distributions.

	Norway (N = 1,037)			United States (N = 1,026)		
	GM soybean oil	GM-fed salmon	GM salmon	GM soybean oil	GM-fed salmon	GM salmon
Nothing	43.8	44.6	38.6	48.4	47.1	51.1
1-20% more	28.8	31.2	36.3	28.9	28.2	26.0
21- 50% more	4.4	5.1	6.7	7.9	10.3	7.5
> 50% more	3.1	2.2	3.8	2.8	3.0	5.7
"Do not know"	19.9	16.8	14.8	11.9	11.4	9.7
P-value [a]	0.75	0.18	0.00			

Source: The table is based on information in Table 3 in Rickersten et al. (2017).
Note: [a] The *p*-value of the Kruskal-Wallis test on whether the samples originate from the same distribution.

Table 2 provides the mean values and standard deviations of the sociodemographic variables. The income was recorded in nine intervals and measured in US$ in the US and in NOK in Norway. Each respondent's income was set to the midpoint of the income group, except for the highest and lowest income groups where the censoring point was set as the income. The log of income was used in the subsequent analyses. Dummy variables represent gender, education, marital status, the presence of children, whether the respondent lived or had lived on a farm, and whether the respondent lived in a city with more than 100,000 inhabitants. The last column of the table reports the *p*-values of unpaired *t*-tests for identical mean values of the variables in the two countries. Except for gender, the observed differences are significant at the 5% level. The Norwegian respondents were older, wealthier, and more educated. A larger proportion was also married or had cohabitants and lived or had lived on a farm, and a lower proportion was residing in cities and had children living in the household.

Table 2. Mean and Standard Deviations (SD) of the Sociodemographic Variables.

		Norway		United States		
Variable	Description	Mean	SD	Mean	SD	P-value
Age	Age of respondent in years	53.93	15.03	40.45	12.70	0.00 [b]
Income	Log of household's income [a]	6.16	0.81	3.89	0.72	0.00 [b]
Male	= 1 if male	0.52	0.50	0.52	0.50	0.97 [c]
Education	= 1 if completed bachelor or more	0.64	0.48	0.55	0.50	0.00 [c]
Married	= 1 if married or cohabitant	0.71	0.46	0.57	0.49	0.00 [c]
Children	= 1 if children aged 18 years or less live in the household	0.30	0.46	0.44	0.50	0.00 [c]
Farm	= 1 if lives or has lived on a farm	0.32	0.47	0.19	0.39	0.00 [c]
City	= 1 if lives in city > 100,000 inhabitants	0.29	0.45	0.43	0.50	0.00 [c]

Source: The table is based on the information in Table 4 in Rickersten et al. (2017) for 746 respondents in Norway and 824 respondents in the US. The values for our Farm variable are different due to some typos in Rickersten et al. (2017).
Notes: [a] The income variable was divided into nine groups, and the household's income was set to the midpoint of the income group. For the highest and lowest income groups, the censoring point was used as income. Income was measured in US$ in the US and in NOK in Norway. [b] The *p*-value of an unpaired *t*-test for identical mean values in Norway and the US. [c] The *p*-value of a Pearson's chi-squared test of independence of the binary variable in the two samples.

The personality traits were measured by a short version of the Big Five model proposed by Engvik and Clausen (2011), which is based on 20 items (BFI-20). Table 3 presents the personality traits, their definition according to American Psychology Association's dictionary (American Psychological Association, n.d.), and the items associated with each trait. The items were measured by self-reported scores on a scale from 1 (the item does not describe the respondent at all) to 7 (the item describes the respondent very well). Table 3 also reports the mean values and standard deviations of the 20 items for each country. The scores of the items with negative wordings are reversed, and higher mean values indicate higher level of the associated trait. An asterisk indicates a significant difference at the 5% level between the mean values of the items across the countries. Except for five items, the mean scores are significantly different.

Table 3. The OCEAN Traits with Mean and Standard Deviations of the Associated Itemsa.

		Norway		United States	
Trait and items	APA definition of trait[b]	Mean[c]	SD	Mean[c]	SD
Openness to Experience	The tendency to be open to new aesthetic, cultural, or intellectual experiences				
Original		4.14*	1.35	4.93*	1.42
Imaginative		4.53*	1.51	5.12*	1.46
Ideas		4.28*	1.44	4.99*	1.38
(non) Unaesthetic[d]		4.45*	1.87	4.18*	1.89
Conscientiousness	The tendency to be organized, responsible, and hardworking				
Thorough		5.63	0.99	5.66	1.28
(non) Careless[d]		4.80	1.41	4.66	1.67
(non) Messy[d]		5.51*	1.53	4.85*	1.76
Discipline		4.89*	1.23	5.17*	1.41
Extraversion	An orientation of one's interests and energies toward the outer world of people and things rather than the inner world of subjective experience				
Talkative		4.06*	1.48	4.29*	1.66
(non) Quiet[d]		4.16*	1.63	3.60*	1.68
(non) Shy[d]		5.06*	1.47	3.85*	1.72
Social		4.66	1.45	4.67	1.62
Agreeableness	The tendency to act in a cooperative, unselfish manner				
Helpful		5.22*	1.19	5.43*	1.37
(non) Cold[d]		5.10*	1.40	4.45*	1.67
Friendly		5.65	1.06	5.63	1.28
(non) Rude[d]		5.05	1.48	4.91	1.67
Neuroticism	A chronic level of emotional instability and proneness to psychological distress				
Depressed		2.38*	1.44	3.05*	1.76
(non) Relaxed[c]		3.06*	1.42	3.39*	1.63
Worried		3.56*	1.69	4.20*	1.89
Nervous		2.90*	1.54	3.77*	1.80

Notes: [a] Based on 746 respondents in Norway and 824 respondents in the US. [b] Definitions according to APA's Dictionary of Psychology (n.d.).[c] An asterisk indicates significance at the 5% significance level for an unpaired *t*-test of identical mean values in Norway and the US [d] The score of the item is reversed.

For each individual and each trait, the score was constructed as the mean score of the four items associated with the trait. In columns 2 - 4 of Table 4, the mean scores, standard deviations, and Cronbach's alpha values (α) for each trait and each country are reported. In both countries, respondents identify themselves as high on conscientiousness and agreeableness and low on neuroticism. Cronbach's alpha values above 0.6 suggest construct reliability (Hair et al., 2014), and except for conscientiousness in Norway the values indicate sufficient construct reliability. The correlation matrix of the constructed OCEAN traits is also shown in Table 4, and an asterisk indicates a significant correlation at the 5% level. Several correlations are significant, but none is above 0.5. For ease of interpretation, the scores were standardized to have zero mean and a unit standard deviation for the subsequent analyses.

We used the 12 food values suggested by Bazzani et al. (2018). As compared with Lusk and Briggeman (2009) the value 'tradition' was excluded and the values 'novelty' and 'animal welfare' were added. Table 5 provides the food values and their definitions.

Table 4. Mean Values, Standard Deviations, and Correlations of the OCEAN Traits.

				Correlation matrix[a]				
Trait	Mean	SD	α^b	O	C	E	A	N
Norway (N = 746)								
Openness to Experience	4.35	1.12	0.72	1.00				
Conscientiousness	5.21	0.86	0.58	0.00	1.00			
Extraversion	4.49	1.21	0.82	0.19*	0.12*	1.00		
Agreeableness	5.26	0.87	0.62	0.06	0.39*	0.32*	1.00	
Neuroticism	2.98	1.17	0.77	-0.08*	-0.23*	-0.29*	-0.21*	1.00
United States (N = 824)								
Openness to Experience	4.80	1.02	0.61	1.00				
Conscientiousness	5.08	1.05	0.61	0.26*	1.00			
Extraversion	4.10	1.21	0.70	0.23*	0.21*	1.00		
Agreeableness	5.11	1.05	0.66	0.26*	0.50*	0.18*	1.00	
Neuroticism	3.60	1.35	0.75	-0.17*	-0.45*	-0.33*	-0.33*	1.00

Notes: [a] An asterisk indicates significance at the 5% significance level. [b] Cronbach's alpha values represent scale reliability coefficients from the standardized items.

Table 5. Food Values with Descriptions.

Food value	Description
Naturalness	Made without modern food technologies like genetic engineering, hormone treatment and food irradiation
Safety	Eating the food will not make you sick
Environmental impact	Effects of food production on the environment
Origin	Whether the food is produced locally, in the US/Norway or abroad
Fairness	Farmers, processors, and retailers get a fair share of the price
Nutrition	Amount and type of fat, protein, etc.
Taste	The flavor of the food in your mouth
Appearance	The food looks appealing and appetizing
Convenience	How easy and fast the food is to cook and eat
Price	The price you pay for the food
Animal welfare	Well-being of farm animals
Novelty	The food is something new that you have not tried before

Source: The table is based on the information in Table 2 in Bazzani et al. (2018).

3.3. Best-worst scaling

The best-worst scaling (BWS) method was developed by Finn and Louviere (1992). There are several ways to implement this method, and we used the case 1 (also referred to as object case) approach that is commonly used in studies of food values (Bazzani et al., 2018; Lister et al., 2017; Lusk & Briggeman, 2009; Pappalardo & Lusk, 2016). In this approach, a complete rank ordering of the list of items is elicited by presenting the respondents with repeated choice sets, each with a subset of items. The respondent is asked to select the best (most important) and the worst (least important) items in the set. A nearly balanced incomplete block design (NBIBD) was used. Twelve choice sets were designed, each set included four food values, and each value was repeated four times across the sets and paired with other values 1.09 number of the times. All respondents were given all the choice sets and could only choose one pair of the most important (best) and least important (worst) food value in each set.[3]

Following Pappalardo and Lusk (2016), we used the counting method to calculate the respondent-specific scores for the importance of each food value. For each respondent, we counted the number of the times each food value was chosen as most important and the number of the times each food value was chosen as least important across the 12 choice sets. We then subtracted the number of times it was chosen as least important from the number of times it was chosen as most important and obtained the best-worst score. These scores are referred to as the importance scores (or best-worst scores) (Lusk & Briggeman, 2009; Pappalardo & Lusk, 2016). Each food value appeared four times across the 12 choice sets and the range of the importance scores are from -4 to 4. They sum to zero across all food values, i.e., the importance scores are effect coded and zero implies the mean level of importance.

Table 6 reports the mean values and standard deviations of the food values. For each country, the Best (Worst) column reports the mean best (worst) scores, i.e., the number of the times the food value was chosen as most (least) important across the 12 choice sets. Everybody chose one food value as most important and one food value as least important in each choice set, and the sum of the mean values in the best column is 12 in each country and this is also the case for the Worst column. The Best-Worst column reports the average of the best minus the worst scores, and the column sums to zero. The last column reports the *p*-values of an unpaired *t*-test for identical mean values of the best minus worst score in the two countries for each food value. Except for safety and taste, they are significantly different at the 5% level. Safety is the most important and novelty is least important food value in both countries.

Table 6. Mean Values and Standard Deviations of the Food Values.

	Norway (N = 746)			United States (N = 824)			
	Best	Worst	Best-Worst	Best	Worst	Best-Worst	P-value [b]
Safety	2.42 (1.30)	0.09 (0.36)	2.34 (1.46)	2.40 (1.42)	0.22 (0.58)	2.19 (1.77)	0.07
Naturalness	1.48 (1.37)	0.43 (0.84)	1.05 (1.90)	1.16 (1.25)	0.83 (1.04)	0.33 (2.01)	0.00
Environmental impact	0.93 (1.07)	0.70 (0.95)	0.23 (1.70)	0.68 (0.91)	0.88 (1.06)	-0.20 (1.66)	0.00
Fairness	1.00 (1.12)	0.64 (0.94)	0.36 (1.76)	0.65 (0.86)	0.98 (1.01)	-0.32 (1.54)	0.00
Nutrition	1.19 (1.26)	0.58 (0.88)	0.61 (1.85)	1.37 (1.18)	0.48 (0.78)	0.89 (1.67)	0.00
Taste	1.43 (1.38)	0.27 (0.52)	1.16 (1.64)	1.65 (1.33)	0.37 (0.70)	1.28 (1.74)	0.16
Price	0.83 (1.22)	1.36 (1.20)	-0.53 (2.15)	1.34 (1.28)	0.89 (1.09)	0.45 (2.09)	0.00
Appearance	0.48 (0.75)	1.42 (1.13)	-0.95 (1.65)	0.63 (0.77)	1.17 (1.14)	-0.54 (1.65)	0.00
Animal welfare	1.02 (1.34)	0.34 (0.76)	0.68 (1.73)	0.79 (1.13)	0.77 (1.12)	0.02 (1.86)	0.00
Origin	0.81 (1.11)	1.50 (1.25)	-0.69 (2.09)	0.64 (0.86)	1.56 (1.15)	-0.92 (1.77)	0.02
Convenience	0.34 (0.75)	1.83 (1.21)	-1.49 (1.71)	0.50 (0.76)	1.39 (1.17)	-0.89 (1.68)	0.00
Novelty	0.08 (0.33)	2.86 (1.20)	-2.78 (1.36)	0.19 (0.51)	2.47 (1.33)	-2.28 (1.62)	0.00

Notes: [a] Mean values of the scores obtained from counting method with standard deviations in the parentheses. [b] The *p*-value of an unpaired *t*-test for identical mean values in Norway and the US.

3.4. Subjective expected utility and WTP

In expected utility theory, the probabilities are usually assumed to be objective. However, in food choice situations the probabilities are typically unknown and

[3] A more detailed discussion of the BWS method, the NBIBD design used in this choice experiment, and other aspects of the experiment are provided in Bazzani et al. (2018).

likely to be subjective and respondent specific. Following several studies (Lusk, 2011b; Lusk et al., 2014b; Pappalardo & Lusk, 2016), we interpret these subjective probabilities as subjective beliefs. Look at one respondent who is consuming one product that exists in different varieties with $k = 1, \ldots, K$ attributes. Let P_{ij}^{k} be respondent i's subjective belief that variety j provides attribute k. We follow Lusk (2011b) and Pappalardo and Lusk (2016), and interpret the attributes as food values, FV, and the utility obtained from each food value of the product is $U_i(FV_k)$. The subjective expected utility respondent i gets from variety j of the product is SEU_{ij}, or:[4]

$$SEU_{ij} = \sum_{k=1}^{K} P_{ij}^{k} U_i(FV_k). \quad (1)$$

Variety A of the product will be chosen over variety B when $SEU_{iA} > SEU_{iB}$, or in terms of Equation (1) when $\sum_{k=1}^{K}\left(P_{iA}^{k} - P_{iB}^{k}\right)U_i(FV_k) > 0$. We extend the model used in Lusk (2011b) and Pappalardo and Lusk (2016) and let the SEU be associated with respondent-specific characteristics such as sociodemographic status and personality traits. We consider two varieties of the product, one that is a GM variety (*GM*) and one that is a conventional non-GM variety (*C*). The SEU of respondent i for the GM variety is:

$$SEU_{iGM} = \gamma_{GM} + \sum_{k=1}^{K} P_{iGM}^{k} U_i(FV_k) + \sum_{l=1}^{L} \beta_{iGM}^{l} Z_{il} - \alpha price_{GM} \quad (2)$$

where γ_{GM} is a constant term, Z_{il} is the level of respondent-specific characteristic l, β_{iGM}^{l} is the associated parameter, α is the marginal utility of income, and $price_{GM}$ is the price of the GM variety.

The SEU for the conventional variety is:

$$SEU_{iC} = \gamma_{C} + \sum_{k=1}^{K} P_{iC}^{k} U_i(FV_k) + \sum_{l=1}^{L} \beta_{iC}^{l} Z_{il} - \alpha price_{C}. \quad (3)$$

As discussed in Section 2, many studies have confirmed that price discounts are needed to make individuals willing to accept GM products (Ardebili & Rickertsen, 2020; Lin et al., 2019; Lusk et al., 2005). Consequently, we assume that there is a WTP premium for the conventional product as compared with its GM counterpart. This premium is calculated by solving for the price difference that equates the SEUs in Equations (2) and (3), or:

$$WTP = (price_C - price_{GM}) = \frac{(\gamma_C - \gamma_{GM}) + \sum_{k=1}^{K}\left(P_{iC}^{k} - P_{iGM}^{k}\right)U_i(FV_k) + \sum_{l=1}^{L}\left(\beta_{iC}^{l} - \beta_{iGM}^{l}\right)Z_{il}}{\alpha}. \quad (4)$$

3.5. Econometric Model

Each respondent stated the WTP to avoid three GM products, which gives a panel structure to data. The WTP values were recorded in intervals. We used a random effects interval regression model to take the interval-coding of the WTP values and the panel structure of the data into account. Following Rickersten et al. (2017), we specified each respondent's latent WTP^* to avoid the GM varieties as:

$$WTP_{i,GM}^{*} = G_1 X'_i \lambda_1 + G_2 X'_i \lambda_2 + G_3 X'_i \lambda_3 + v_i + e_{i,GM} \quad (5)$$

where subscript GM denotes the GM varieties of three products (GM soybean oil, GM-fed salmon, and GM salmon); $G_1 = 1$ for the first product and 0 otherwise, $G_2 = 1$ for the second product and 0 otherwise, and $G_3 = 1$ for the third product and 0 otherwise; X'_i is a vector of the explanatory variables, and $\lambda_1, \lambda_2,$ and λ_3 are the parameter vectors. The respondent-specific random variation v_i is assumed to be constant across products and iid $N(0, \sigma_v^2)$. The observation-specific random variation $e_{i,GM}$ is assumed to be independent of v_i and $N(0, \sigma_e^2)$. The proportion of the total variance contributed by the panel-level variance component is $\rho = \frac{\sigma_v^2}{\sigma_v^2 + \sigma_e^2}$. When this proportion is high, the respondent-specific variation is high, the panel structure is important, and a pooled estimator will give incorrect standard errors. We used the -xtintreg- procedure in Stata/MP 15 to estimate the model (StataCorp, 2017).

4. Results

Model 1 included only the sociodemographic variables, Model 2 added the personality traits, and Model 3 included all the variables. In Model 3, the price was excluded to avoid perfect multicollinearity among the food values as discussed above.[5] First, we estimated country specific unrestricted versions of the models with product-specific effects and alternative specific constants (ASCs). Second, we excluded the product-specific effects, and tested these restricted models by likelihood-ratio tests. The restricted versions were never rejected (p-values > 0.2). Finally, we tested the restricted versions of Model 1 and Model 2 against the restricted version of Model 3. Model 1 ($p <$ 0.00) and Model 2 ($p < 0.00$) were rejected in both countries, and we discuss the results of the restricted version of Model 3.

4.1. Norway

Table 7 shows the estimated coefficients and associated standard errors for the Norwegian models. An asterisk indicates significance at the 5% level. The proportion of the total variance explained by the panel-level variance component is high in all models ($\rho > 0.81$), which indicates the importance of panel structure of the data.

The ASCs can be interpreted as the average WTP premiums for a hypothetical reference respondent, i.e., a single zero-year-old female with no income, no university degree, no children, who never has lived on a farm, does not live in a city, scores zero on all personality traits, and find all the food values to be of average importance. None of the ASCs are significantly different from zero.

Some sociodemographic variables, none of the OCEAN traits, and many food values are significantly associated with the WTP premiums to avoid GM foods. The coefficients can be interpreted as the change in the WTP premium for a non-GM food as a result of a one unit increase in the associated variable. Income, education and

[4] Equation (1) is a subjective expected utility theory model (Savage, 1954). Subjective expected utility theory is an extension of the expected utility theory of Von Neumann and Morgenstern (1944).

[5] We choose to exclude the price from the model because we expected that price sensitive respondents would have higher acceptance of GM foods, and our results seem to correspond well with this hypothesis.

having lived on farm are positively associated with higher WTP to avoid the GM alternatives. Education has the greatest impact, and respondents who had completed a bachelor's degree or more have on average 2.5 percentage points higher WTP to avoid GM foods as compared with other respondents.

All the changes in importance of a food value are relative to the importance of price, i.e., the excluded food value. The coefficients reflect the difference in subjective beliefs about the conventional product versus the GM alternative with respect to each food value (Lusk, 2011a; Pappalardo & Lusk, 2016), and all the significant food values illustrate the importance of subjective beliefs. They imply that respondents perceived non-GM foods to be more safe, more natural, with less negative impact on the environment, and have a better area of origin than the GM alternatives. They also perceived the non-GM foods to be fairer, more appealing, better for the welfare of animals, and more convenient than the GM alternatives. A one unit increase in the relative importance scores of each of these food values increased the WTP premium for the conventional products between 1.1 and 2.2 percentage points.

Table 7. Coefficient Estimates and Associated Standard Errors, Norway.

	Model 1		Model 2		Model 3	
Variable	Coefficient[a]	SE	Coefficient[a]	SE	Coefficient[a]	SE
Age	0.03	0.03	0.04	0.03	-0.00	0.03
Income	1.56*	0.61	1.57*	0.61	1.30*	0.56
Male	-3.09*	0.92	-3.00*	0.96	-0.27	0.92
Education	2.92*	0.97	2.81*	0.97	2.52*	0.91
Married	-0.49	1.05	-0.31	1.06	0.48	0.98
Children	0.32	1.07	0.48	1.07	0.30	1.00
Farm	3.21*	1.01	3.34*	1.00	2.20*	0.94
City	0.40	1.03	0.20	1.04	0.20	0.95
Openness[b]			0.64	0.46	0.27	0.44
Conscientiousness[b]			0.66	0.56	0.88	0.52
Extraversion[b]			-0.35	0.51	-0.07	0.48
Agreeableness[b]			-0.12	0.58	-0.34	0.53
Neuroticism[b]			0.77	0.55	0.79	0.51
Safety					1.04*	0.34
Naturalness					2.24*	0.33
Environmental impact					1.81*	0.35
Fairness					1.23*	0.32
Nutrition					0.60	0.33
Taste					0.38	0.43
Appearance					1.40*	0.37
Animal welfare					1.13*	0.37
Origin					1.24*	0.29
Convenience					1.48*	0.40
Novelty					0.83	0.44
ASC GM soybean oil	-4.73	3.88	-4.98	3.87	-3.00	3.95
ASC GM-fed salmon	-4.83	3.88	-5.08	3.87	-3.11	3.95
ASC GM salmon	-3.20	3.88	-3.45	3.87	-1.48	3.95
N[c]	2,238		2,238		2,238	
Log likelihood	-4,858		-4,855		-4,787	
AIC	9,743		9,748		9,632	
BIC	9,817		9,850		9,798	
ρ	0.84		0.84		0.81	
p-value LR-test[d]			0.38		0.00	

Notes: [a] An asterisk implies significance at the 5% level. [b] Standardized net traits. [c] Balanced panel with three observations per respondent (746 respondents). [d] The *p*-values of likelihood ratio tests for the significance of adding the personality traits to Model 1 and adding the food values to Model 2.

4.2. The United States

Table 8 presents the estimated coefficients and associated standard errors for the US models. The proportion of the total variance explained by the panel-level variance component in each model is quite high ($\rho > 0.62$). All the ASCs are statistically significant. Age is negatively associated with WTP to avoid GM foods, and respondents who live or have lived on a farm have 3.7 percentage points higher WTP to avoid GM foods than others.

Two personality traits are significant. A one standard deviation increase in the score of extraversion increases the WTP to avoid GM foods, and one standard deviation increase in the score of agreeableness decreases the WTP to avoid GM foods by around 1.0 percentage point.

The effects of the food values imply that respondents perceived non-GM foods to be more natural, more nutritious, have less negative impact on the environment, be fairer and more appealing than the GM alternatives. They also perceived the non-GM foods to be better for the animal welfare, more convenient, to have a better area of origin, and somewhat surprisingly to be more novel than the GM alternatives. A one unit increase in the relative importance scores of each of these food values increased the WTP premium for the conventional products between 1.0 and 2.9 percentage points.

Table 8. Coefficient Estimates and Associated Standard Errors, United States.

	Model 1		Model 2		Model 3	
Variable	Coefficient[a]	SE	Coefficient[a]	SE	Coefficient[a]	SE
Age	-0.25*	0.03	-0.22*	0.03	-0.12*	0.03
Income	1.39*	0.70	1.28	0.69	1.12	0.64
Male	1.37	0.87	1.05	0.87	0.09	0.82
Education	0.22	0.94	0.15	0.92	0.13	0.85
Married	0.35	0.98	0.61	0.96	-0.05	0.88
Children	2.36	0.92	2.09*	0.90	1.44	0.83
Farm	5.52*	1.09	4.91*	1.08	3.75*	1.00
City	2.30*	0.86	1.81*	0.84	0.76	0.77
Openness[b]			0.65	0.44	0.13	0.41
Conscientiousness[b]			-1.01	0.52	-0.35	0.48
Extraversion[b]			1.54*	0.45	1.11*	0.41
Agreeableness[b]			-1.73*	0.49	-1.03*	0.46
Neuroticism[b]			0.41	0.50	0.69	0.46
Safety					0.50	0.28
Naturalness					1.95*	0.28
Environmental impact					1.35*	0.31
Fairness					1.42*	0.33
Nutrition					1.05*	0.31
Taste					0.72	0.38
Appearance					1.75*	0.34
Animal welfare					1.19*	0.31
Origin					1.53*	0.29
Convenience					1.93*	0.34
Novelty					2.95*	0.32
ASC GM soybean oil	8.71*	2.85	8.29*	2.86	14.88*	2.70
ASC GM-fed salmon	9.37*	2.85	8.94*	2.86	15.53*	2.70
ASC GM salmon	9.74*	2.85	9.32*	2.86	15.90*	2.70
N[c]	2,472		2,472		2,472	
Log likelihood	-6,144		-6,120		-6,046	
AIC	12,314		12,275		12,150	
BIC	1,2390		1,2380		1,231	
ρ	0.69		0.67		0.62	
p-value LR-test[d]			0.00		0.00	

Notes: [a] An asterisk implies significance at the 5% level. [b] Standardized net traits. [c] Balanced panel with three observations per respondent (824 respondents). [d] The *p*-values of likelihood ratio tests for the significance of adding the personality traits to Model 1 and adding the food values to Model 2.

5. Discussion

The associations between personality traits and attitudes towards GM foods are different from some previous results. In the US, extraversion is positively, and agreeableness is negatively associated with WTP to avoid GM foods, while Lin et al. (2019) found the opposite results for the valuation of GM pork in the US. In contrast with the findings in Ardebili and Rickertsen (2020), the OCEAN traits are not associated with WTP to avoid GM products in Norway. This may be somewhat surprising since they used identical products, measurement of the attitudes, and personality traits. However, they used a different sample, did not include food values, and used confirmatory factor analysis to construct the personality traits.

Most of the food values are significant, which demonstrates the importance of subjective beliefs. Furthermore, the effects are quite consistent across the two countries with different market structure and cultural characteristics. In both countries, respondents perceived the GM products to be cheaper than the conventional products. Moreover, they believed that conventional products are more natural, better for animal welfare, have less negative environmental impacts, and are more likely to be produced locally. Previous studies have also found similar consumer opinions about GM foods across culturally diverse countries, for example United Kingdom and Poland (Popek & Halagarda, 2017). The respondents also believed that application of GM technology is unfair towards farmers, processors, and retailers. Perceptions about unfairness of GM technologies are in line with findings in Lusk et al. (2018), who found that consumers' concerns about the distributional effect of adopting GM technologies across the food supply chain affect attitudes towards GM foods. Perceived negative environmental impacts and unnaturalness of GM foods relative to conventional products are also in line with older studies with similar results (Bredahl, 1999; Frewer et al., 1996). This apparent stability over time of subjective beliefs was also discussed in Tonsor et al. (2018) and Lusk and Briggeman (2009), who argued that preferences over food values are relatively stable. Such stability also corresponds with Honkanen and Verplanken (2004) who argued that attitudes stemming from more general values are quite stable and less likely to change when the external environment is changing.

There are some differences in subjective beliefs about GM foods in the two countries. First, nutritional beliefs affect the WTP to avoid GM foods in the US, while they have no effect in Norway. Second, safety is insignificant in the US, i.e., respondents do not believe conventional products are safer than GM products. In Norway, safety has significant effects on WTP. This difference in beliefs about the safety of GM foods is reasonable given that genetic engineering has been widely adopted in the US while GM foods are banned in Norway. Previous studies also suggest that restrictive government policies are associated with GM-food aversion (Ardebili & Rickertsen, 2020; Lusk, 2011b; Pakseresht et al., 2017).

Our results indicate that food values are more important than personality traits, which correspond well with the results in Huynh and Olsen (2015). They studied consumers' attitudes towards home-meal preparations and found that personal values have stronger effects on individuals' attitudes than personality traits. However, Whittingham et al. (2020) found that the role of personal values in determining attitudes towards GM foods are mediated by individuals' personality traits in a study among Twitter users. This result suggests that both personality traits and values are important when studying food-related attitudes and behaviors.

6. Conclusions, Implications, and Limitations

We investigated the importance of food values, personality traits and sociodemographic status in determining attitudes towards GM soybean oil, GM-fed salmon, and GM salmon. As far as we know, this is the first attempt to link food values to attitudes towards GM foods. Attitudes were measured using WTP to avoid GM alternatives. The data was collected using an online survey in Norway and the US. We followed Pappalardo and Lusk (2016) and conceptualized the relationships between food values and WTP to avoid GM foods as indicators of subjective beliefs regarding conventional food products versus GM foods. The effects of sociodemographic status and personality traits on WTP premiums are country specific. Income and education are significant variables in Norway and age in the US, while living on a farm is significant in both countries. In the US, extraversion and agreeableness are the only significant personality traits, and no traits are significant in Norway.

Most of the food values are significant, which demonstrates the importance of subjective beliefs. Moreover, the effects of food values are quite consistent across the two countries. An increase in the importance of naturalness, environmental impact, fairness, appearance, animal welfare, origin, and convenience relative to price, increase the aversion towards GM foods. In Norway, respondents perceive GM products to be less safe than conventional products, while there is no such perception in the US. Our results suggest that relevant information and more liberal policies towards GM foods may increase GM acceptance in Europe.

Our findings have some implications. First, a large part of the resistance against GM foods seems to be based on beliefs that they are less natural, less fair to stakeholders in the supply chain, and more harmful to the environment and the welfare of animals. Given such beliefs credible information is important, even though the information provision does not seem to be very successful so far (Dixon, 2016; Lusk et al., 2004). Previous information has to a large extent emphasized the safety of GM foods for human consumption. However, new information also needs to emphasize the potential environmental benefits of genetic modification technologies and that these technologies are equally natural as other breeding technologies. Furthermore, it should be emphasized that there is nothing inherent in gene modification that reduce animal welfare or fairness. It is also important to focus on potential benefits of the technology for local and domestic production. For example, GM resistance may be reduced by promoting the environmental benefits through, for example, creating pesticide-free labeling equivalents. The risks may also be less and the benefits more evident to consumers for the CRISPR technology as compared with traditional genetical modification technologies (Bartkowski et al., 2018). Second, our results suggest that consumers' current safety concerns about GM foods may be reduced if European governments adopt more liberal policies towards GM foods

(Pakseresht et al., 2017). Finally, businesses could try and attract price sensitive consumers by promoting the low prices of GM food products.

There are some limitations in this study. First, the personality traits were measured using a short version of the Big Five model. A longer version with more items would provide more nuances. However, such versions would also be more complex and take more time for the respondents in surveys not focusing only on personality traits. Second, a nearly balanced incomplete block design (NBIBD) was used for the allocation of food values across the choice sets in the BWS experiment. Other designs such as balanced incomplete block design (BIBD) have better properties. However, given a fixed number of original items, BIBD increases the size or number of choice sets, which would increase the complexity and cognitive burden and influence respondents' attentiveness to the choice task (Scarpa & Rose, 2008). Third, the data was collected through an online survey where the respondents' attentiveness was not controlled for. Fourth, the samples are not completely representative for the populations in the two countries with respect to some socioeconomic variables. Both samples are more educated than their respective country populations. About 63% and 51% of the Norwegian and the US respondents, respectively, had a university degree as compared with 33% and 28% in the two populations. In the Norwegian sample, the average age is 53 years as compared with a population average of 39 years, and 54% were married as compared with 35% in the population. Fifth, there are some possible limitations with the WTP questions. The premiums were stated without real economic incentives, which potentially can result in a hypothetical bias in stated WTP values. Furthermore, the respondents had no alternative to express a positive WTP for the GM alternatives. Previous studies have found that framing of the questions may affect consumers' attitudes and evaluation of GM foods (Hess et al., 2016; Hu et al., 2006). However, allowing both positive and negative WTP values for the GM alternatives would add to the complexity and could introduce confusion among the respondents. Finally, we asked about respondents' WTP to avoid the GM-food products without any explanation of the technology. As discussed in Lusk et al. (2018), the terms GM foods or genetic technology are no longer referring to a single product or technology, but rather several possible technologies, and questions with more nuances could be beneficial.

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Declarations of Interest

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