Determinants for the Social Acceptance of New Emerging Science and Technology: The Case of Genetically Modified Foods

Seoyong Kim*

Abstract

This study identifies the structural determinants of the social acceptance of genetically modified (GM) foods across European countries. Toward this end, we suggest an integrated theoretical model to explain the social acceptance of GM foods by including both perception factors (perceived benefit, perceived risk, feelings, trust, and knowledge) and value factors (ethical concerns, science optimism, religiosity, and ideology). This model is then tested by analyzing survey data collected from 18,634 Europeans in 32 countries.

The results indicate that first, not only perception factors but also value factors significantly contribute to explaining the acceptance of GM foods. Second, perceived benefits, perceived risk, feelings, and ethical concerns tend to be the four biggest determinants for acceptance. Third, this two-factor model could be generalized even with variation across countries. Finally, ethical concerns and scientific optimism play a moderating role between predictors and outcomes in the acceptance of GM foods.

Keywords

Social Acceptance of Science and Technology, GMO (Genetically Modified Foods), Risk Perception, GM foods

1. INTRODUCTION

Although we derive many conveniences and benefits from emerging technologies, the public can sometimes refuse or resist these technologies despite their obvious advantages. Public policies related to emergent technologies, for example in the cases of genetically modified organisms (GMO), nanotechnology, biotechnology, and energy technology, may face social resistance even when they

* Professor, Department of Public Administration, Ajou University, Suwon, Korea, seoyongkim@ajou.ac.kr

significantly benefit the public. Although there have been rapid changes and advances in modern science and technology, social acceptance for these advances have been slow. For example, analysis by Gaskell et al. (2002) of trends from 1991 to 2002 of the social acceptance of information technology, computers, and biotechnology report that support for new science and technology is steadily decreasing. There was also widespread pessimism regarding biotechnology in 1990. Additionally, Taylor-Gooby (2006) found that there is a great deal of skepticism over GMO, and four out of five Americans disapprove of using cloning technology for birth (Science and Engineering Indicators, 2008).

From an economics perspective, new science and technology, such as information technology (IT), biotechnology (BT), nanotechnology (NT), environmental technology (ET), space technology (ST), and culture technology (CT), tends to increase a nation's international economic competitiveness. Indeed, it is under this pretext in which many countries have invested much of their budget in these fields. According to data from Roco (2003), the amount of investment in nanotechnology around the world exceeded US$ 3 trillion in 2003, a 670% increase over the 1997 amount. Moreover, there were 56,828 patents for intellectual rights related to nanotechnology in 2002. The economic impact of nanotechnology is expected to be US$ 100 trillion (production-driving effect) by 2015, and the field is expected to employ seven million people. Additionally, the Korean government has established five technologies (IT, BT, NT, ST, CT) as strategic industries for national development, invested 13 trillion won from 2004 to 2008 in these fields, and expects to continue with these plans in the future. However, with the present distrust of new science and technology, social resistance could effectively block the government's efforts to develop the science and technology.

Why is there such social resistance even in the face of substantial benefits from new sciences and technologies? To answer this question, a new perspective and theoretical view on science and technology are needed. Short (1984) argues that we should regard science and technology as by-products of social construction, and that acceptance of science and technology depends heavily on not just the technologies themselves but also on the subjective social constructions that people conceive. For example, perceived risk, one of the critical factors in social resistance, is socially constructed. Perceived risk is not a matter of any technology system but of human or social systems. In this vein, Frewer et al. (1998) stresses the importance of the social aspects of technology. Moreover, Lomax (2000) argues that not only do the science and technology factors influence risk perception and acceptance of science and technology but so do cultural factors. Hence, there is strong demand for systemic research on the social acceptance of new and emerging sciences and technologies. This work demands a new general model that integrates different theories and explains the social acceptance of new and emerging sciences and technologies. It would also be necessary to both empirically test the model and identify the causal determinants of the acceptance of science and technology.

This study will focus on identifying the general structural determinants of social acceptance for emerging science and technology, in particular regarding GM foods across European countries. Because there are few models for integrating the fragmented variables, we propose a new model based on perception factors (perceived benefit, perceived risk, feelings, trust, and knowledge) and value factors (ethical concerns, scientific optimism, religiosity, and ideology). To establish the possibility of generalizing the proposed model, we compare the determinant structures across thirty-two European countries. We then empirically test the ways in which such causal factors influence the acceptance of GM foods by analyzing not only the direct relationships between the predictor and outcome variables but also the moderating role of the value factors between them.

2. THEORETICAL BACKGROUND

2.1. Research Model

Many studies have attempted to identify the determinants of social acceptance of GMO and its applications (Bredahl, 2001; Chen, 2011; Costa-Font & Mossialo, 2007; Frewer et al., 1997; Frewer et al., 2003; Gaskell et al., 2003, 2004; Honkanen & Verplanken, 2004; Knight, 2009; Miles, 2006; Mohr et al., 2007; Poortinga & Pidgeon, 2006; Siegrist, 2000). These studies were empirically conducted at the individual level rather than at the group or national levels using quantitative methods far more often than in qualitative studies. Even though they contribute to identifying patterns in the social acceptance of GMO, these studies have certain limits in terms of theoretical perspective.

First, these previous studies were performed without the benefit of a more integrated theoretical model and tend to focus on a few specific variables. For example, Slovic and Sjöberg gave attention only to perceived risk and benefit; Siegrist and Cevtkovich (200) and Siegrist (2000) only focused on trust; Kahn et al. (2009) looked only at culture; and Miller (2004) looked only at knowledge. These narrower approaches that lack a general theoretical model are limited in providing a more comprehensive understanding of GMO acceptance.

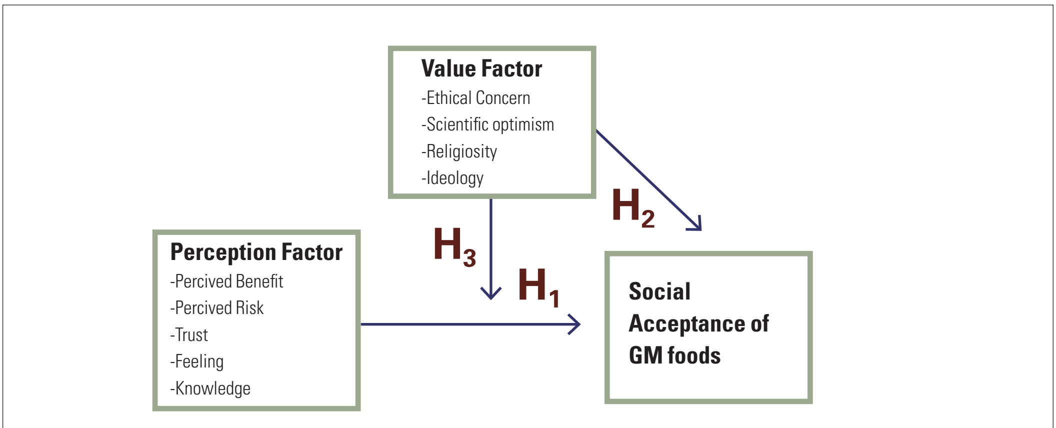
Some studies do suggest a theoretical model illuminating the acceptance of science and technology. For example, according to Poortinga and Pidgeon (2006), attitudes toward GMO can vary along three evaluation dimensions such as general evaluation, involvement, and attitudinal certainty, all of which produces negative, positive, and ambiguous attitudes.

Second, the previous findings did not look at the role of contextual or moderating factors on the causes and outcomes of social acceptance of GMO. The contextual factor is important because the same causes do not always bring about the same results. Such relationships between cause and effect can be changed according to a third or more intervening factors. For example, Chen (2011) examined whether gender differences play an intervening role in relationships between consumers' food choice motives (mood, sensory appeal, price, familiarity, and natural content) and their attitudes toward GM foods.

Third, most studies were executed in only one or just a few countries, such as Australia (Mohr et al., 2007); Denmark, Germany, Italy, and the UK (Bredahl, 2001); Norway (Honkanen & Verplanken, 2004); Switzerland (Siegrist, 2000); Taiwan (Chen, 2011); the UK (Costa-Font & Mossialo, 2007; Frewer et al., 1997); and the US (Knight, 2009). This brings into question the universality of the findings and their applicability into other national contexts.

To mitigate these three problems, we suggest the value-perception model as shown in Figure 1. In this model, the social acceptance of GM foods is decided by both perception and value factors. The former includes perceived risk and benefit, trust, negative images, and knowledge, while the latter has to do with ethics, optimism about science, religiosity, and ideology. Perception factors directly influence the social acceptance of GM foods (Hypothesis 1). Value factors serve not only as direct determinants of the social acceptance of GM foods (Hypothesis 2) but also as moderating factors influencing the relationship between perceptual causes and GM food acceptance (Hypothesis 3). Since value factors have more fundamental attributes, they play a contextual role in influencing both the perception and attitude toward GM foods. To determine the possibility of generalizing the proposed model, we compare the determinant structures of thirty-two countries.

FIGURE 1. The Value-Perception Model of Social Acceptance of GM Foods



These two factors were chosen as our main theoretical components because they move us closer to revealing the full picture of the determinants of GMO acceptance. Previous studies disregard value factors because these factors depend on psychometric paradigms. Psychometric paradigms have focused on perception factors, that is, the degree of perceived risk, the characteristics of the risk, and acceptable levels of risk (Slovic, 2000). Based on revealed preferences, risk studies have stressed (1) the subjective idea of risk, not the objective, (2) the psychological aspect of the criteria for risk judgment, (3) the key interests of the public, and (4) the importance of the cognitive structure of risk judgment (Rohrmann & Renn, 2000).

However, the psychometric paradigm has limits. It does not consider culture and values, even if they are important factors in risk judgement. Wildavsky (1987) argued that cultural biases filter cognitive thinking. Even when perception influences GMO acceptance in direct ways, it does not explain all of the variation in GMO acceptance. Just as perception and values have their own characteristics, they also have distinctive domains of explanation. According to the empirical studies of de Groot et al. (2011), the acceptability of risk depends not only on perceived benefit and risk but

also on values such as egotism or altruism. Honkanen and Verplanken (2004, p. 401) showed that negative attitudes towards GM foods are embedded in universal and hedonistic values. Moreover, value as a more fundamental factor intervenes in the process whereby individuals' perceptions of benefit, risk, trust, feelings, and knowledge influences their acceptance of GMO.
In the next section, we review existing studies related to perception and value factors.

2.2. Perception Factors

Perceived Risks and Benefits: Findings generally reveal that perceived benefits increases the social acceptance of GM foods whereas perceived risks decreases it. For example, Gaskell et al. (2004) demonstrated the positive and negative impacts of perceived benefits and risks on support for GM foods. Siegrist (2000) found that perceived risks have a negative impact on the acceptance of gene technology whereas perceived benefits positively relate to it. He also observed that perceived benefits negatively influence the perceptions of risk in the case of GM foods. Miles et al. (2006) found that intention to purchase GM foods are higher when their benefits are specified, compared with when benefits are not specified.

Several studies have focused on how the relationship between perceived risks and benefits influence acceptance of science and technology. Bredahl et al. (1998) assumed that in the case of genetic engineering, if the perceived risks were seen to outweigh benefits, consumer acceptance would be low. Similarly, Costa-Font and Mossialos (2007) showed that perception of greater benefits has a negative impact on risk perception: high risks imply low benefits and vice versa (p. 179).

However, in terms of comparative studies, Townsend et al. (2004) showed that GM food, relative to nineteen other current concerns, is "not dreaded," are judged as "controllable," and are seen as the least "risky" among all the issues, even though these foods possess unknown risk.

Feeling: Recent risk studies focus on the role of affective feeling (Slovic, 1999; Slovic et al., 2004). Feelings play an important role in the acceptance of technology. Townsend et al. (2004) determined that integral affect, for example, dread, consistently influences risk judgment, whereas the determinants that have high incidental affect do not differ significantly from those with low affect.

Different feelings play different roles in risk judgment. Townsend (2006, p. 126) distinguished integral affect from incidental. The former is considered to be feelings held about a risk-related object or issue, or the anticipation of how one may feel after a decision has been made about the issue, whereas incidental affect refers to the general feelings experienced at the time of making a risk-related judgment or decision.

Trust: Trust—measured by separately asking whether government, industry, and businesses were doing a good or bad job—encourages support for GM foods (Gaskell et al., 2004). However, not all trust predicts the acceptance of technology. Mohr et al. (2007) demonstrated that differing levels of trust in information sources leads to differing levels of acceptance. For example, trust in scientists increases acceptance of the benefits of science, but trust in non-experts or producers does not have the same effect. Frewer et al. (2003, p. 1117) offered the alternative view that trust should be seen as a consequence rather than a cause of attitudes toward GM foods. The extent to which people trust the information sources appear to be driven by their attitudes toward GM foods, rather than trust affecting the way that people react to the information.

Knowledge: Scientific knowledge is an important factor in the acceptance of GMO foods. Based on a cognitive deficit model, Bodmer (1985) argued that lack of knowledge influences the general public's lack of the support for technology. According to Gaskell et al. (2004), biological knowledge increases the support for GM foods. Klerck and Sweeney (2007) examined the effect of both objective and subjective knowledge on perceived risk and consumer behaviors associated with GM foods. They found that objective knowledge about GM foods significantly decreases performance and psychological risks. However, subjective knowledge only affects perceived physical risks. Moreover, the impact depends on the consumer's level of objective knowledge.

2.3. The Value Factor

Ethical Concerns: Ethical issues play an important role in the public response to scientific research on living plants and animals. Ethical considerations seem to be greater for genetic engineering than for other technology applications (Slovic, 1992). Nature and intrinsic ethical concerns are some of the reasons that opponents have protested against GMO (Verhoog, 2003). Brossard et al. (2009, p. 547) explained that because technology is seen as disturbing nature and natural processes, it seems to be perceived as risky and immoral. Gaskell et al. (2000) found that moral concerns about the "unnaturalness" of technology are negatively related with acceptance of GMO. Moreover, Bredahl (2001) demonstrated that beliefs (e.g., genetically modified products interfere with nature) influence the perceived risks and benefits of GM foods, which determine the attitudes toward GM food products.

However, according to Townsend et al. (2004), compared with 19 other current concerns, GM foods are not viewed as "unethical."

Scientific Optimism: Optimistic attitudes toward technology have an impact on the perceived benefits and risks of GMO (Bredahl, 2001). After arguing that optimists—those who believe technology will improve our lives—will show more support for biotechnology, Gaskell et al. (2004) showed that those who are pessimistic about the contributions of technology to society have a higher probability of both being more skeptical and perceiving fewer benefits coming from technologies. According to Mohr et al. (2007), pro-science and technology attitudes (for example, "most problems can be solved by applying more and better technology") increase the acceptance of technology innovation in terms of social benefit and indulgence. In this vein, when Mohr et al. (2007) tested whether general acceptance toward science and technology was a major predictor of the acceptance of both genetic engineering and its applications, they concluded that general receptiveness toward science and technology is the primary predictor of genetic engineering (GE) acceptance and a major predictor of the acceptance of each application area (p. 1169).

In a macro context, there exists a cultural divide in scientific optimism between countries. When comparing public perceptions of technologies in the US and in Europe, those in the US appear more optimistic than Europeans do (Gaskell et al., 2005b).

Religiosity: Recently, several studies examined how religiosity or religious beliefs can shape public attitudes toward science and technology (Gaskell et al., 2005; Nisbet, 2005). However, religiosity is not a significant predictor of the perceived risks and benefits of GM foods, which may influence the acceptance of GM foods (Costa-Font & Mossialos, 2007).

Ideology: Costa-Font and Mossialos (2007) demonstrated that conservative political tendencies increase perceived risk, which could reduce the acceptance of science and technology and of GMO. Looking at genetic engineering and applications of new technology in Australia (N = 686), Mohr et al. (2007) reported that conservative values negatively influence the acceptance of technological innovation.

3. DATA AND MEASUREMENTS

We analyzed the data from the Eurobarometer 73.1: The European Parliament, Biotechnology, and Science and Technology survey. The total number of respondents interviewed was 31,238 across thirty-two countries. GM food questions were asked of 18,634 respondents. The social survey was carried out between January 29, 2010 and February 25, 2010 through face-to-face interviews. The Eurobarometer 73.1 survey covers the population of twenty-seven European Union members, four candidate countries (Bulgaria, Romania, Croatia, and Turkey), and three European Free Trade Association countries (Iceland, Norway, and Switzerland). Separate samples were drawn for Northern Ireland and eastern Germany. The basic sample design adopted the multistage, random probability method. In each country, a number of sampling points were drawn with probability proportional to population size and population density. For detailed information about the survey, please refer to the GESIS Eurobarometer Web site (http://www.gesis.org/en/eurobarometer/ survey-series) and ZACAT (http://zacat.gesis.org/webview).

Table 1 shows all measures for theoretical concepts. To enhance the reliability of measures, if possible, we used multiple measures for one concept. To composite the multiple measures, we used the mean values calculated from several questions.

TABLE 1. Factor, Variables and Measurement

Factor	Variables	Question Statement	Scale
GM Food Acceptance		The development of GM food should be encouraged	Four point scale (1. Totally disagree, 4. Totally agree)
	Awareness	Have you ever heard of genetically modified (or GM) foods (nanotechnology, animal cloning) before?	1. No, 2. Yes
Perception Factor	Perceived benefit	For each of the following issues regarding GM food please tell me if you agree or disagree with it. -GM food is good for the (NATIONALITY) economy/-GM food helps people in developing countries	Four point scale (1. Totally disagree, 4. Totally agree)
	Perceived risk	For each of the following issues regarding GM food please tell me if you agree or disagree with it. -GM food is safe for future generations/-GM food is safe for your health and your family's health	Four point scale (1. Totally agree, 4. Totally disagree)
	Feeling	For each of the following issues regarding GM food please tell me if you agree or disagree with it. -GM food makes you feel uneasy	Four point scale (1. Totally disagree, 4. Totally agree)
	Trust	For each of the following people and groups, do you think they are doing a good job for society or not doing a good job for society? 1. Newspapers, magazines and televisions, 2. Industries, 3. University scientists, 4. Consumer organizations, 5. Environmental groups, 6. Governments, 7. Retailers, 8. The European Union, 9. Ethics committees, 10. Religious leaders, 11. Medical doctors	1. Not doing a good job for society 2. Doing a good job for society
	Knowledge	I would like you to tell me for each of the following issues in the news if you feel very well informed, moderately well informed or poorly informed about it. -New medical discoveries / -New scientific discoveries and technological developments	1. Poorly informed 2. Moderately well 3. Very well informed informed
Value Factor	Ethical Concern	For each of the following issues regarding GM food please tell me if you agree or disagree with it. -GM food is fundamentally unnatural	Four point scale (1. Totally disagree, 4. Totally agree)
	Science Optimism	I would like to read out some statements that people have made about science, technology or the environment. For each statement, please tell me how much you agree or disagree. -Thanks to scientific and technological advances, the Earth's natural resources will be inexhaustible / -Science and technology can sort out any problem	Five point scale (1. Totally disagree, 5. Totally agree)
	Religiosity	Which of these statements comes closest to your beliefs?	1. You don't believe there is any sort of spirit, god or life force, 2. You believe there is some sort of spirit or life force, 3. You believe there is a god
		Apart from weddings or funerals, about how often do you attend religious services? Eight point scale (1. Never, 8. More than once a week)	Eight point scale (1. Never, 8. More than once a week)
	Ideology	In political matters people talk of "the left" and "the right". How would you place your views on this scale?	Ten point scale (1. Right, 10. Left)

TABLE 2. Correlation

	GM food acceptance	Gender	Age	Education	Social class	Awareness
GM food acceptance	1					
Gender (Female)	-.137***	1				
Age	-.059***	.018***	1			
Education	.053***	-.031***	-.115***	1		
Social class(the highest)	.080***	-.041***	-.057***	.257***	1	
Awareness	-.024***	-.037***	-.026***	.231***	.137***	1
Perceived benefits	.603***	-.084***	-.049***	.066***	.087***	0.013
Perceived risks	-.716***	.099***	.050***	-.035***	-.079***	.037***
Feelings	-.509***	.125***	.093***	-.048***	-.059***	.024***
Trust	.082***	.011*	-.066***	.054***	.068***	.079***
Knowledge	.077***	-.069***	-.024***	.193***	.179***	.167***
Ethical concerns	-.425***	.083***	.049***	-.029***	-.056***	.042***
Scientific optimism	.137***	-.027***	-.055***	-.124***	-.033***	-.120***
Religiosity	-.081***	.131***	.135***	-.162***	-.035***	-.106***
Ideology (left)	-.041***	.022***	0.008	.024***	-.086***	-0.015

*p < .1; ** p < .05; ***p < .01

	Perceived benefit	Perceived risk	Feeling	Trust	Knowledge	Ethical concern	Scientific optimism	Religiosity
GM food acceptance								
Gender (Female)								
Age								
Education								
Social class(the highest)								
Awareness								
Perceived benefits	1							
Perceived risks	.611***	1						
Feelings	-.394***	.509***	1					
Trust	.102***	-.073***	0.005	1				
Knowledge	.070***	-.083***	-.049***	.067***	1			
Ethical concerns	-.291***	.427***	.577***	.024***	-.042***	1		
Scientific optimism	.077***	-.144***	-.049***	.074***	.020***	-.101***	1	
Religiosity	-.086***	.080***	.106***	.029***	-.064***	.039***	.096***	1
Ideology (left)	-.035***	.033***	.046***	-.014	-0.01	.022*	-.060***	-.129***

*p < .1; ** p < .05; ***p < .01

4. ANALYSIS AND FINDINGS

As shown in Table 3, in order to identify the relative explanatory power of determinants of GM food acceptance, we regressed it on the sociodemographic factors in Model 1, the perception factors in Model 2, the value factors in Model 3, and finally, all 3 factors in the full model.

In Model 1, based on five variables, from the adjusted R-square of 2.9%, social demographic factors explained very little of the variance in the acceptance of GM foods, although the model's F-values were significant. Also, from the significance of the regression coefficients, women compared to men showed more negative attitudes toward GM foods. The results confirmed Chen (2011)'s findings that female consumers have more negative attitudes toward GM foods than did male consumers when they considered whether GM foods were healthy or not. In the case of age, acceptance of GM foods decreased among older people. Such results can be understood in terms of conservatism, an attitude that may be held more by older people rather than younger ones. The older people are more sensitive to ethical issues than the younger do. Education also increased the acceptance of GM foods. Respondents in higher socioeconomic classes expressed more positive attitudes toward GM foods. From the resource's hypothesis, those in higher socioeconomic classes tend to possess the means to avoid the possible risks. Hence, they feel less risk than did poorer respondents. Awareness of risk decreased the acceptance of GM foods.

Model 2 produced the greatest changes in F-value, 2784.164, and R-square, 55.6%. Such a large change implies that perception factors largely contribute to explaining the variance in acceptance of GM foods. From the regression coefficients, it is possible to infer that perceived benefit, trust, and knowledge had a positive impact on GMO food acceptance, whereas perceived risk and feelings showed negative effects. However, knowledge did not show a significant impact on acceptance. It is notable that more literacy and information about GM foods did not increase acceptance.

In a comparison of the standardized betas, perceived risk appeared to explain the greatest amount of variance, followed by perceived benefits and feelings. Among perception factors, trust possessed the least variance in explaining the acceptance.

With Model 3, the value factors increased the explained variance, R^2 = 20.1% with F-value at 587.629 (P-value < .01). However, Model 2's F-value and the R^2 change in Model 3 were less than that of Model 2, suggesting that the perception factors were more proximal and relevant in terms of statistical meaning. Viewing the significance of each coefficient, optimism about science had a positive impact on acceptance whereas ethical concerns, religiosity, and ideology exerted a negative effect. Among the four variables, ethical concerns showed the greatest power of explanation of the social acceptance of GM foods.

Based on the F-value and adjusted R^2, the full model exhibited the power of explanation at 59.6%. These higher figures imply that the model mainly consisting of the perception and value factors will largely contribute to explaining the acceptance of GM foods. Viewing the significance of each coefficient across the three models, education, perceived benefit, trust, knowledge, and scientific optimism generally had positive impacts on acceptance whereas gender, awareness, perceived risk, feeling, and ethical concern show negative impacts.

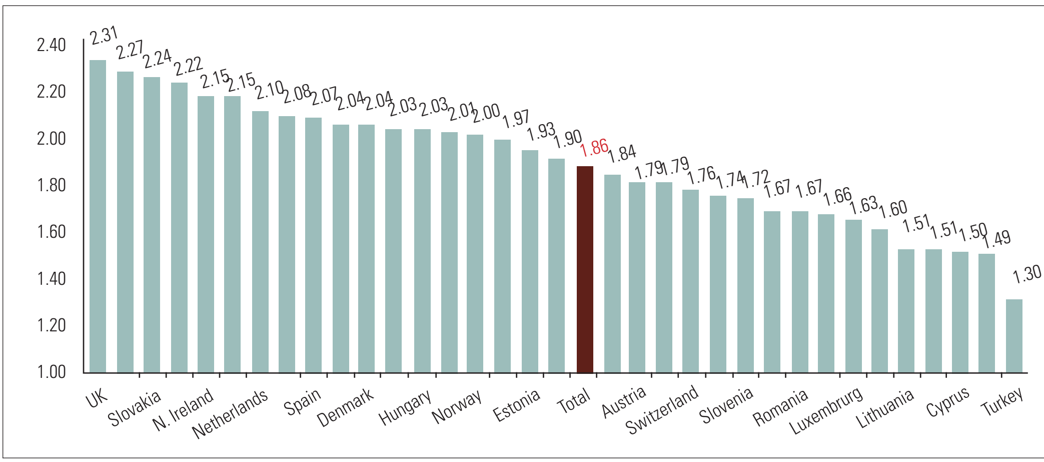
Based on the standardized regression coefficients, acceptance of GM foods depended heavily on the perceived risk, followed by perceived benefit, feelings, ethical concerns, and gender, whereas awareness had a weaker impact, followed by education, trust, and scientific optimism. The big "four variables" are perceived benefit, perceived risk, feelings and scientific optimism.

In short, perception factors, followed by value factors, contributed to explaining the social acceptance of GM foods. Among the independent variables, perceived risk, perceived benefit, feelings, and scientific optimism played a role in determining the direction and degree of acceptance of GM foods.

To establish the possibility of generalizing from the value-perception model, regression analyses were conducted for each of the thirty-two countries, as shown in Table 4. Because of space limitations, only the standardized regression coefficients are provided. Before interpreting the regression results, to see the basic state of acceptance, social acceptance in the thirty-two countries was depicted by calculating mean value, as shown in Figure 2. The difference in means across countries was statistically significant (ANOVA F-Value = 33.701, P-value < 0.01).

On a 4-point scale, the total mean was 1.86, meaning a low level of support. Simple frequency of response (totally disagree 43.8%, tend to disagree = 31.4%, tend to agree = 19.4%, totally agree = 5.4%) confirmed this low level of support. Specifically, 75.2% of respondents did not support GM foods. However, these levels of acceptance of GM foods varied by country. Also as shown in Figure 2. The UK revealed the strongest support for GM foods whereas Turkey showed the least support.

FIGURE 2. Means of Social Acceptance of GM foods (4-point scale)



This variation across countries was also found in the regression analyses for each of the thirty-four cases for the thirty-two countries, as shown in Table 4. Several rules underlying the analysis results were found as follows.

First, to judge the model's explanation power, we computed the R^2. Northern Ireland had the highest value at 76.1%, followed by Ireland (73.8%), Malta (71.9%), Bulgaria (69.6%), the Czech Republic (69.1%), Iceland (68.9%), Austria (68.4%), Slovakia (67.4%), Italy (67.3%), and the UK (66.2%); Turkey showed the lowest value, 19.9%, followed by Luxemburg (35.7%), Lithuania (37.0%), Latvia (40.0%), Estonia (40.2%), Slovenia (45.0%), Romania (45.5%), Cyprus (46.1%), France (48.7%), and Greece (48.8%). From Figure 2, with the exception of Austria and Bulgaria, countries with higher R^2 values showed greater support for GM foods, scoring higher than the mean, whereas with the exception of Estonia, countries with lower R^2 values had scores lower than the mean value. These relationships suggested that the present model's fit depends on the level of social support such that higher level of acceptance provides a background for the model's significance.

Second, the number of significant standardized beta-coefficients suggests which predictors will be generalized across countries. Perceived risk had a significant effect in all thirty-four cases for the thirty-two countries. Next, perceived benefit was significant in twenty-eight countries, followed by feelings in nineteen countries. However, religiosity was significant only in Malta and western Germany. Additionally, social class, awareness, and ideology showed significance in three countries. Those variations in significance suggest the possibility of generalizing the model's predictors is different across countries.

Third, based on the direction of the standardized beta-coefficients, it was a generalized rule across countries that perceived benefit, scientific optimism, and religiosity exerted positive effects on the acceptance of GM foods, whereas gender, perceived risk, feelings, and ethical concerns showed a negative effect.

Education generally had a positive impact on acceptance except across some countries. However, there were contrasting findings in Norway. Age increased the acceptance in Northern Ireland but decreased it in Sweden, Poland, and Slovakia. Higher socioeconomic status enhanced acceptance in Croatia whereas lower status reduced it in Malta and Lithuania. Moreover, awareness raised the acceptance in Austria but decreased it in western Germany and Italy. Knowledge increased acceptance in Poland but decreased it in Ireland and Croatia. Left-leaning ideology increased acceptance in Slovakia but diminished it in Italy. Such different roles for the same variables may come from either weak relationships between these and the outcome variable or the significant power of the contextual variables.

Fourth, based on the size of the standardized beta-coefficients, with the exception of Sweden and Latvia, perceived risk ranked first across all countries. The second and third predictors of explanation power alternated between perceived benefits and feelings. However, the order varied across countries. Ethical concerns outranked feelings in Belgium, eastern Germany, and Estonia and scored higher than perceived benefits and feelings in Austria. In Luxemburg, instead of feelings, trust had the third highest power of explanation. Such different scores across countries imply that country as context plays a significant role in the acceptance of GM foods.

Lastly, the changes in F-value and R^2, when we added the perception factors or the value factors to the sociodemographic variables, each showed significant contributions except in Turkey. Perception factors resulted in a greater R^2 change than did the value factor. Among R^2 changes in the perception factor, Ireland had the largest value, 71.4%, followed by Northern Ireland (70.8%), the Czech Republic (68.4%), Malta (66.3%), and the UK (65.9%), whereas Turkey had the smallest value, 29.3%, followed by Luxembourg (34.8%), Lithuania (37.5%), and Estonia (40.8%). In the case of the value factors, Austria (42.0%), eastern Germany (40.0%), and the UK (33.4%) showed a greater than 30% change in R^2, whereas in Luxembourg (9.4%), Lithuania (9.3%), and Poland and Croatia (7.7%), the change was less than 10%. The gap in the R^2 change between the first- and the last-ranked countries revealed 30.6% for the perception factors and 34.3% for the value factors, showing that the two factors do, to the greatest extent, play different roles across countries.

In short, a generalizable rule was found in which perceived benefit, perceived risk, and feelings among the perception factors and ethical concerns among the value factors played a large and significant role in explaining the social acceptance of GM foods. Full models based on the three factors have different powers of explanation across countries, with R^2 ranging from 76.1% to 29.3%. Based on the R^2 change, perception and value factors made significant contributions to increasing the acceptance of GM foods. Moreover, the perception factors were superior to the value and socio-demographic factors. These variations across countries were revealed in the R^2 changes.

TABLE 3. Regression Analysis

Factor	Variable	Model 1: Socio-Structural Model			Model 2: Perception			Model 3: Value			Model 4: Full Model		
		b	S·E	Beta	b	S·E	Beta	b	S·E	Beta	b	S·E	Beta
SDF (Sociodemographic Factors)	Constant	1.967	.062		3.485	.062		3.165	.084		3.580	.079	
	Gender (Female)	-.253***	.017	-.140	-.079***	.012	-.043	-.180***	.017	-.098	-.080***	.013	-0.043
	Age	-.002***	.001	-.034	.000	.000	-.003	-.001*	.001	-.016	.000	.000	-0.002
	Education	.007***	.002	.041	.002	.001	.009	.007***	.002	.040	.003***	.001	0.02
	High socioeconomic status	.037***	.005	.066	.004	.004	.007	.021***	.005	.036	.000	.004	0
	Awareness	-.123***	.025	-.046	-.036*	.018	-.013	-.040	.027	-.014	-.044**	.021	-0.015
PF (Perception Factors)	Perceived benefit	-	-	-	.243***	.009	.224	-	-	-	.235***	.010	0.214
	Perceived risk	-	-	-	-.543***	.010	-.490	-	-	-	-.524***	.011	-0.472
	Feeling	-	-	-	-.154***	.007	-.166	-	-	-	-.129***	.009	-0.138
	Trust	-	-	-	.008***	.002	.025	-	-	-	.008***	.002	0.025
	Knowledge	-	-	-	.010	.011	.006	-	-	-	.004	.012	0.002
VF (Value Factors)	Ethical Concern	-	-	-	-	-	-	-.433***	.009	-.428	-.076***	.009	-0.075
	Scientific Optimism	-	-	-	-	-	-	.084***	.008	.095	.025***	.006	0.028
	Religiosity	-	-	-	-	-	-	-.006***	.001	-.047	.000	.001	0.003
	Ideology (left)	-	-	-	-	-	-	-.012***	.004	-.030	-.003	.003	-0.008
F-Value		7.458			1471.508***			301.193***			884.208***		
Adjusted R-square		.029			.585			.231			.596		
R-Square Change		-			.556			.201			.005 (R^2 change if VF adds to SDF, PF)		
F-Change		-			2794.146***			587.629***			23.239*** (F-value change if VF adds to SDF, PF)		

*p < .1; ** p < .05; ***p < .01

TABLE 4. Determinants of Social Acceptance of GM Foods across Countries

	Total (N=18634)	France (N=422)	Belgium (N=440)	Netherlands (N=447)	W. Germ (N=452)	Italy (N=424)	Luxem (N=226)	Demark (N=437)	Ireland (N=292)	UK (N=397)	N. Ireland (N=105)	Greece (N=432)
SDF (Sociodemographic Factors)												
Gender (Female)	-.043***	-.059	-.082**	-.065*	-.051	.008	-.041	-.124***	-.038	-.018	.056	-.029
Age	-.002	.046	-.059	.012	.008	-.061	.089	-.011	.041	-.008	.187**	-.033
Education	.020***	.003	.042	-.003	.000	.077*	-.029	.080**	.006	.001	.168**	-.051
High socioeconomic status	.000	.004	.048	.036	-.005	-.050	-.068	.026	.040	.035	.011	.039
Awareness	-.015*	.052	-.048	-.027	-.080**	-.072*	-.045	.037	-.003	-.049	.047	-.003
PF (Perception Factors)												
Perceived benefits	.214***	.202***	.206***	.211***	.284***	.169***	.304***	.153***	.001	.196***	.170	.119**
Perceived risks	-.472***	-.410***	-.381***	-.425***	-.412***	-.663***	-.367***	-.342***	-.722***	-.472***	-.796***	-.568***
Feelings	-.138***	-.197***	-.114**	-.135**	-.205***	-.023	.051	-.153***	-.173**	-.192***	.067	-.059
Trust	.025***	.043	-.046	.015	.084**	-.014	-.128*	.024	.051	.039	-.033	-.025
Knowledge	.002	.026	.050	.006	.003	-.047	-.041	.006	-.084*	-.018	.068	-.029
VF (Value Factors)												
Values	-.075***	-.017	-.127***	-.090**	-.040	-.052	-.117	-.199***	.045	-.070	-.173	-.048
Scientific Optimism	.028***	.046	.065	.080**	.014	.026	.056	.070*	.044	-.006	.043	.047
Religiosity	.003	.014	-.020	.029	.059*	-.020	-.031	-.033	.029	-.004	.078	.004
Ideology (left)	-.008	-.002	.002	-.028	-.001	-.073*	-.019	-.026	-.059	.051	-.067	-.020
F-Value	884.208***	20.389***	27.895***	30.135***	47.111***	34.215***	6.190***	29.168***	33.992***	27.907***	12.365***	18.888***
Adjusted R-square	.596***	.487***	.537***	.579***	.656***	.673***	.357***	.531***	.738***	.662***	.761***	.488***
F-Value change if PF adds to SDF	2794.146***	59.914***	67.187***	80.580***	128.446***	104.426***	19.518***	61.726***	112.828***	113.325***	42.101***	67.044***
R^2 change if PF adds to SDF	.556	.461	.447	.517	.609	.611	.348	.425	.714	.659	.708	.462
F-Value change if VF adds to SDF	587.629***	14.16***	422.363***	23.321***	33.878***	15.706***	3.789***	32.987***	15.332***	29.202***	4.864***	14.693***
R^2 change if VF adds to SDF	.201	.168	.198	.203	.273	.195	.094	.246	.235	.334	.257	.177

	Spain (N=383)	Portugal (N=348)	E. Germany (N=249)	Finland (N=422)	Sweden (N=483)	Austria (N=439)	Cyprus (N=208)	Czech Republic (N=444)	Estonia (N=439)	Hungary (N=420)	Latvia (N=491)	Lithuania (N=441)
SDF (Sociodemographic Factors)												
Gender (Female)	-.039	-.010	.044	-.037	-.035	-.088***	-.094	-.004	-.022	-.104***	-.111**	-.017
Age	.044	.098	.018	.002	-.105***	.035	.022	-.041	.013	.058	-.005	-.077
Education	.071	.083	-.027	.053	.002	.023	.065	*.057	-.006	-.014	.049	.018
High socioeconomic status	-.043	.002	-.050	-.058	.022	-.033	-.042	.005	.026	-.029	-.075	-.118*
Awareness	.036	-.001	-.053	.009	-.043	.090***	-.116	*.054	-.062	-.030	.007	-.080
PF (Perception Factors)												
Perceived benefits	.056	.283***	.251***	.168***	.308***	.158***	.068	.251***	.199***	.130**	.292***	.069
Perceived risks	-.670***	-.449***	-.438***	-.600***	-.235***	-.503***	-.573***	-.426***	-.374***	-.576***	-.209***	-.507***
Feelings	-.016	.029	-.080	-.069	-.260***	-.070	-.146	-.185***	-.103*	-.076	-.169***	-.083
Trust	.066	-.035	.038	-.015	-.025	.004	.029	.103***	.052	-.030	-.036	-.066
Knowledge	.003	-.045	.058	-.031	.004	.044	.048	-.024	-.039	.017	.017	.095
VF (Value Factors)												
Values	-.086	-.172**	-.170**	-.015	-.124***	-.187***	-.035	-.072*	-.116*	-.088	-.147**	-.031
Scientific Optimism	.050	.053	.019	-.015	.058	.062	.036	-.011	.070	.029	-.004	.004
Religiosity	.025	.080	.004	-.001	-.017	.020	-.079	-.033	.020	.011	-.012	.084
Ideology (left)	.020	-.017	-.041	-.065*	-.046	.032	-.036	-.013	-.014	-.013	.055	.017
F-Value	23.171***	15.161***	26.356***	37.745***	45.045***	51.096***	7.159***	53.668***	13.853***	37.596***	15.256***	9.212***
Adjusted R-square	.585***	.534***	.660***	.615***	.609***	.684***	.461***	.691***	.402***	.620***	.400***	.370***
F-Value change if PF adds to SDF	80.060***	67.074***	67.542***	91.192***	88.625***	129.738***	24.925***	164.748***	52.324***	118.019***	48.200***	38.284***
R^2 change if PF adds to SDF	.579	.573	.625	.509	.443	.622	.466	.684	.408	.591	.375	.349
F-Value change if VF adds to SDF	16.232***	13.420***	31.490***	17.110***	30.161***	63.220***	4.292**	30.237***	13.057***	33.129***	16.985***	5.212**
R^2 change if VF adds to SDF	.207	.220	.400	.157	.195	.420	.138**	.249	.157	.284	.176	.093*

	Malta (N=149)	Poland (N=374)	Slovakia (N=455)	Slovenia (N=479)	Bulgaria (N=399)	Romania (N=382)	Turkey (N=429)	Croatia (N=456)	Norway (N=500)	Switzerland (N=487)	Iceland (N=253)
SDF (Sociodemographic Factors											
Gender (Female)	.008	-.062	-.019	.028	-.077*	.021	-.016	-.043	-.095***	-.074**	-.023
Age	.118	-.142***	-.078**	-.061	.055	-.074	.052	-.013	.013	-.042	.000
Education	.188**	.006	.065**	-.028	.036	.005	.109	.025	-.070*	-.033	.112**
High socioeconomic status	-.325***	.019	-.045	.019	-.022	-.066	.071	.077*	.008	.054	-.012
Awareness	-.055	-.014	.040	.061	-.031	-.045	-.007	-.038	-.041	-.036	.035
PF (Perception Factors)											
Perceived benefits	.116	.278***	.242***	.099	.334***	.228***	.240**	.330***	.194***	.301***	.225***
Perceived risks	-.601***	-.505***	-.405***	-.464***	-.444***	-.492***	-.271**	-.435***	-.426***	-.375***	-.364***
Feelings	-.340***	-.069	-.204***	-.164***	-.216***	-.113	.011	-.205***	-.131***	-.186***	-.275***
Trust	-.103	.004	.033	-.002	.069*	.056	.114	.008	.010	.044	-.069
Knowledge	.144*	.096**	.015	.010	.029	.057	-.133	-.074*	.028	-.005	-.029
VF (Value Factors)											
Values	.118	-.027	-.105***	-.084	-.033	.035	.034	.081	-.108**	-.048	-.101*
Scientific Optimism	.114	.055	.025	.093*	.035	.107*	-.136	-.004	.046	.058*	-.038
Religiosity	.173**	.082	.039	.074	.048	.024	-.029	-.004	-.017	-.026	.026
Ideology (left)	-.035	.052	.078**	.084	-.020	.084	.009	-.003	-.004	.022	-.034
F-Value	12.872***	21.723***	50.997***	15.371***	39.236***	11.537***	3.521***	28.677***	37.637***	43.583***	25.660***
Adjusted R-square .	719***	.601***	.674***	.450***	.696***	.455***	.199***	.567***	.582***	.627***	.689***
F-Value change if PF adds to SDF	47.916***	62.410***	144.398***	71.483***	112.932***	61.465***	19.338***	81.569***	95.756***	112.132***	61.397***
R^2 change if PF adds to SDF	.663	.498	.626	.489	.645	.507	.293	.513	.504	.545	.612
F-Value change if VF adds to SDF	4.474**	5.247***	30.136***	12.621***	20.973***	5.304***	1.536	6.400***	31.280***	32.027***	17.710***
R^2 change if VF adds to SDF	.189	.087	.251	.168	.236	.100	.032	.077	.222	.236	.291

*p < .1; ** p < .05; ***p < .01

To learn the moderating effects of value factors, we first checked the significance of the interaction terms. Before calculating the interaction terms, we standardized the moderating variables in the value factors and the moderated ones in the perception factors. We then regressed the acceptance of GM foods on fourteen existing predictors and interaction terms. Findings indicated that only ethical concern and scientific optimism, not religiosity and ideology, played a role as a moderator. The significance of interaction terms, F-values, R^2 changes, and F-value changes are provided in Table 5. The changes in R^2 and F-value were the values when the interaction terms were added to the full model in Table 3. Also, in case of significant moderators, a simple slope test was conducted as shown in <Table 6>. Knowledge variables did not go through the simple slope test.

TABLE 5. Analysis of Interaction Effects

		Ethical Concerns	Optimism about Science
Perceived Benefits	Interaction Term	-.060***	.026***
	F-Value	841.716***	827.996***
	R-Square Change	.005***	.001***
	F-Value Change	100.098***	17.131***
Perceived Risks	Interaction Term	.042***	-.022***
	F-Value	833.803***	827.831***
	R-Square Change	.003***	.001***
	F-Value Change	52.252***	13.354***
Trust	Interaction Term	-.011*	-.015**
	F-Value	.825.645***	826.016***
	R-Square Change	.000*	.000**
	F-Value Change	2.916*	5.159**
Knowledge	Interaction Term	-.012*	n.s.
	F-Value	825.761***	n.s.
	R-Square Change	.000*	n.s.
	F-Value Change	3.617*	n.s.

TABLE 6. Simple Slope Test

		Ethical Concern	Science Optimism
Perceived Benefit	high	B=.146, S·E=010., t=14.860, p<.001	B=.204, S·E=.009, t=24.193, p<.001
	low	B=.268, S·E=.011, t=24.877, p<.001	B=.199, S·E=.008, t=23.747, p<.001
Perceived Risk	high	B=-.380., S·E=.011, t=-33.377, p<.001	B=-.451, S·E=.011, t=-42.573, p<.001
	low	B=-.466, S·E=.010, t=-45.283, p<.001	B=-.406, S·E=.011, t=-35.721, p<.001
Trust	high	B=.013., S·E=.009, t=1.331, p=.1834	B=.009, S·E=.009, t=.976, p=.329
	low	B=.035, S·E=.009, t=3.756, p<.001	B=.039, S·E=.010, t=3.906, p<.001
Knowledge	high	B=-.009, S·E=.009, t=-1.091, p=.275	n.a.
	low	B=.013, S·E=.009, t=1.498, p=.134	n.a.

Interaction effects are illustrated in Figure 3 through Figure 8. Figure 3 shows that the simple slope representing the association between perceived benefit and acceptance of GM foods was positive in relation to acceptance more under low ethical concern than under high ethical concern. Figure 4 shows that the greater the perceived benefit, the greater the acceptance of GM foods. This positive relationship was facilitated with high optimism about science. Figure 5 suggests that as perceived risk increases, acceptance of GM foods decreases. Such decrement occurred more under higher ethical concern. Figure 6 shows that risk's effect on acceptance hinged on scientific optimism. Compared with lower science optimism, higher science optimism more intensified the relationships between perceived risk and acceptance.

Figure 7 illustrates that greater trust increased acceptance. This effect was clearly observed with low ethical concern. Strong ethical concern buffered the positive effect of trust on acceptance. Figure 8 depicts the nature of the relationship between trust and acceptance of GM foods with high and low levels of scientific optimism. Trust increased the acceptance of GM foods. Such effects depended on scientific optimism. When trust increased, the degree of change in acceptance was facilitated by high scientific optimism. Higher optimism had a positive impact on the relationships between trust and acceptance.

Figures 3 through 8 suggest that the effect of perception on acceptance of GM foods depends on value factors. Higher ethical concern suppressed the positive effects of each perceived benefit and trust on acceptance and exacerbated perceived risk's detrimental effect. Higher scientific optimism facilitated the positive effects of perceived benefit and trust on acceptance and reduced perceived risk's detrimental effects.

FIGURE 3. Benefit x Ethical Concern

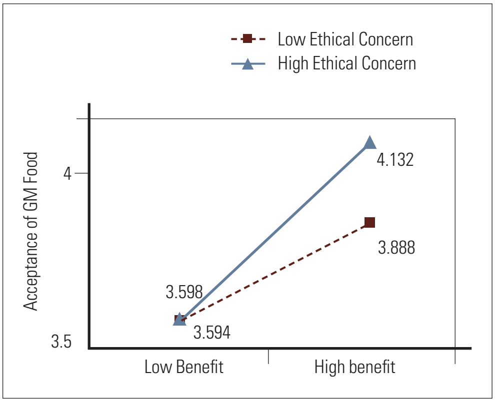


FIGURE 4. Benefit x Science Optimism

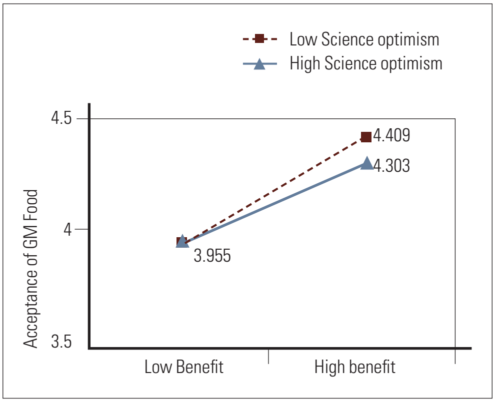


FIGURE 5. Risk x Ethical Concern

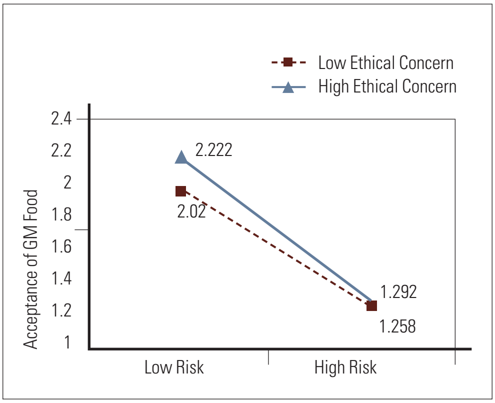


FIGURE 6. Risk x Science Optimism

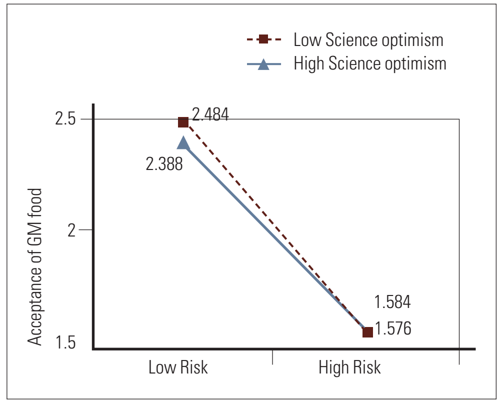


FIGURE 7. Trust x Ethical Concern

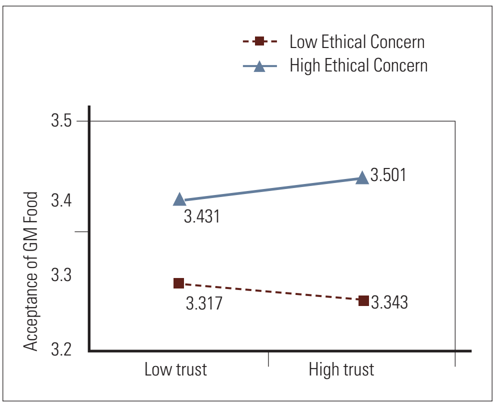
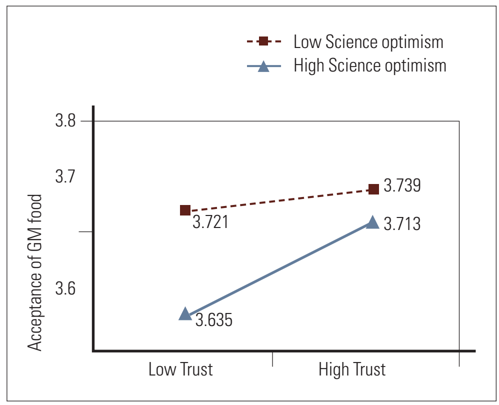


FIGURE 8. Trust x Science Optimism



5. SUMMARY AND IMPLICATION

This study analyzed the determinant structure of the social acceptance of GM foods. After suggesting an integrated theoretical model that included both perception factors (perceived benefit, perceived risk, feelings, trust, and knowledge) and value factors (ethical concerns, scientific optimism, religiosity, and ideology), we empirically analyzed the survey data collected from 31,238 Europeans in thirty-two countries to test the generalization for this suggested model.

We first found that not only do perception factors contribute to explaining the acceptance of GM foods, but also do value factors. The former contributed to greater variance in the dependent variables than did the latter. It is notable that more socially constructed perception and value played a key role in the acceptance of GM foods whereas the socially given sociodemographic variables provided little power of explanation for this acceptance.

Second, among the predictors, education, perceived benefit, trust, and optimism about science increased the acceptance of GM foods whereas being female, awareness, perceived risk, feelings, and ethical concerns decreased such acceptance. In terms of explanation power, perceived benefits, perceived risks, feelings, and ethical concerns were the four variables that largely explained the acceptance.

Third, full models based on three factors can be generalized across countries. By comparing thirty-two countries, we learned that perception factors, followed by value factors, still contribute to explaining the acceptance of GM foods across countries. The big four factors—perceived benefits, perceived risks, feelings, and ethical concerns—were also important for explaining the acceptance across countries. However, there were differing powers of explanation across countries, with R^2 values ranging from 76.1% to 29.3%. Based on the R^2 changes, the perceptions and values both made significant contributions to increasing the acceptance of GM foods. Moreover, perception factors were superior to value or sociodemographic factors. Such variations across countries were reflected in the R^2 changes.

Fourth, from the analysis of moderating effects, we learned that the effects of perception factors on acceptance of GM foods depended on value factors, in particular, ethical concerns and scientific optimism. Higher ethical concerns decreased the positive effects of perceived benefits, and trust on acceptance and aggregated perceived risk's detrimental effects. Scientific optimism facilitated the positive effects of perceived benefits and trust on acceptance, whereas they relieved the detrimental effects of perceived risk.

Based on the empirical findings, we suggest some implications for enhancing the social acceptance of science and technology.

In theoretical terms, we recommend using the more integrated model to explain the social acceptance of new emerging science and technology. This model includes not only perception factors but also value factors, which have relevance in explaining the acceptance of GM foods. This model will contribute to overcoming the problem of fragmented theories that tend to have bias in the micro-psychometric paradigm.

In practical terms, we believe that the information we gathered in our study will be crucial for new science and technology policies for GM foods. Perceived risks, perceived benefits, feelings, and ethical concerns should be the focus in the course of developing policy alternatives.

In terms of comparative studies, we provided useful information about country variations in which different factors or variables across countries contribute to the social acceptance of GM foods. In addition, even with the variation across countries, the more generalized rules still hold: perceived risks, perceived benefits, feelings, and ethical concerns are important factors.

REFERENCES

Bodmer, W. (1985). *The public understanding of science.* London: Royal Society.

Bredahl, L. (2001). Determinants of consumer attitudes and purchase intentions with regard to genetically modified foods –results of a cross-national survey. *Journal of Consumer Policy, 24,* 23–61.

Bredahl, L., Grunert, G., & Frewer, L. J. (1998). Consumer attitudes and decision making with regard to genetically engineered food products –A review of the literature and a presentation of models for future research. *Journal of Consumer Policy*, *21*(3), 251–277.

Brossard, D., Scheufele, D. A. Kim, E., & Lewenstein, B. V. (2009). Religiosity as a perceptual filter: Examining processes of opinion formation about nanotechnology. *Public Understanding of Science, 18*(5), 546-558

Chen, Mei-Fang. (2011). The gender gap in food choice motives as determinants of consumers' attitudes toward GM foods in Taiwan. *British Food Journal, 113*(6), 697 – 709.

Cobb, M. D., & Macoubrie, J. (2004). Public perceptions about nanotechnology: Risks, benefits and trust. *Journal of Nanoparticle Research, 6,* 395-405.

Costa-Font, J., & Mossialos, E. (2007). Are perceptions of risks and benefits of genetically modified food (in)dependent? *Food Quality and Preference, 18*, 173–182.

de Groot, Judith I. M., Steg, L., & Poortinga, W. (2012). Values, perceived risks and benefits, and acceptability of nuclear energy. *Risk Analysis*, *33*(2), 307–317.

Finucane, M. L., Alhakami, A., Slovic, P., & Johnson, S. M. (2000). The affect heuristic in judgments of risks and benefits. *Journal of Behavioral Decision Making, 13*, 1–17.

Frewer, L. J., Howard, C., & Shepherd, R. (1998). Understanding public attitudes to technology. *Journal of Risk Research*, *1*(3), 221-235.

Frewer, L. J., Scholderer, J., & Bredahl, L. (2003). Communicating about the risks and benefits of genetically modified foods: The mediating role of trust. *Risk Analysis*, *23*(6), 1117-1133.

Frewer, L., Howard, C., & Shepherd, R. (1997). Public concerns in the united kingdom about general and specific applications of genetic engineering: Risk, benefit, and ethics. Science Technology Human Values*, 22*(1), 98-124.

Gaskell, G., Allum, N., Bauer, M. W., Jackson, J., Howard, S., & Lindsey, N. (2003). *Ambivalent GM nation? Public attitudes to biotechnology in the UK*, 1991-2002. Life Sciences in European Society Report: London School of Economics and Political Science.

Gaskell, G., Allum, N., Bauer, M., Durant, J., Allansdottir, A., Bonfadelli, H., Boy, D., de Cheveigne, S., Fjaestad, B., Gutteling, J.M., Hampel, J., Jelsoe, E., Jesuino, J.C., Kohring, M., Kronberger, N., Midden, C., Nielsen, T.H., Przestalski, A., Rusanen, T., Sakellaris, G., Torgersen, H., Twardowski, T., & Wagner, W. (2000). Biotechnology and the European public. *Nature Biotechnology, 18*(9), 935–938.

Gaskell, G., Allum, N., Wagner, W., Kronberger, N., Torgersen, H., Hampel, J., & Bardes, J. (2004). GM foods and the misperception of risk perception. *Risk Analysis, 24*(1), 185-194.

Gaskell, G., Einsiedel, E., Hallman, W., Priest, S.H., Jackson, J., & Olsthoorn, J. (2005). Social values and the governance of science. *Policy Forum, 310*, 1908–1909.

Honkanen, P., & Verplanken, B. (2004). Understanding attitudes toward genetically modified food: The role of values and attitude strength. *Journal of Consumer Policy*, *27*, 401–420.

Klerck, D., & Sweeney, J. C. (2007). The effect of knowledge types on consumer-perceived risk and adoption of genetically modified foods. *Psychology & Marketing*, *24*(2), 171–193.

Knight, A. J. (2009). Perceptions, knowledge and ethical concerns with GM foods and the GM process. *Public Understanding of Science, 18*, 177-188.

Lomax, G. P. (2000). From breeder reactors to butterflies: risk, culture, and biotechnology. *Risk Analysis*, *20*(5), 747-753.

Miles, S., Hafner, C., Bolhaar, S., Mancebo, E. G., Fernandez-Rivas, M., Knulst, A., & Hoffmann-Sommergruber, K. (2006). Attitudes towards genetically modified food with a specific consumer benefit in food allergic consumers and non-food allergic consumers. *Journal of Risk Research, 9*(7), 801-813.

Miller, J.D., Pardo, R., & Niwa, F. (1997). *Public perceptions of science and technology: a comparative study of the European Union, the United Status, Japan, and Canada.* Chicago: Chicago Academy of Sciences.

Mohr, P., Harrison, A., Wilson, C., Baghurst, K. I., & Syrette, J. (2007). Attitude, values and socio-demographic characteristics that predict acceptance of genetic engineering and application of new technology in Australia. *Biotechnology Journal, 2*, 1169-1178.

Nisbet, M.C. (2005). The competition for worldviews: Values, information, and public support for stem cell research. *International Journal of Public Opinion Research*, *17*(1), 90–112.

Poortinga, W., & Pidgeon, N. F. (2004). Trust, the asymmetry principle, and the role of prior beliefs. R*isk Analysis, 24*(6), 1475-1486.

Poortinga, W., & Pidgeon. N. F. (2006). Exploring the structure of attitudes toward genetically modified food. *Risk Analysis* , *26*(6), 1707-1719.

Roco, M. C. (2011). The long view of nanotechnology development: the national nanotechnology initiative at 10 years. *Journal of Nanoparticle Research, 13*, 427–445.

Rohrmann, B., & Renn, O. (2000). Risk perception research. In Bernd Rohrmann, & Ortwin Renn (Eds.), *Cross-cultural risk perception: A survey of empirical studies*. Dordrecht: Kluwer Academic Publishers.

Scheufele, D., & Lewenstein, B. V. (2005). The public and nanotechnology: How citizens make sense of emerging technologies. *Journal of Nanoparticle Research, 7*(6), 659-667

Scheufele, D. Corley, E., Shih, T., Dalrymple, K., &. Ho, S. (2008). Religious beliefs and public attitudes toward nanotechnology in Europe and the United States. *Nature Nanotechnology, 7*, 1-4.

Short, J. F. (1984). The social fabric at risk: Toward the social transformation of risk analysis. *American Sociological Review, 49*, 711-725.

Siegrist, M. (2000). The influence of trust and perceptions of risks and benefits on the acceptance of genetechnology. *Risk Analysis, 20*(2), 195–203.

Siegrist, M., & Cvetkovich, G. (2000). Perception of Hazards: The role of social trust and knowledge. *Risk Analysis*, *20*, 713-719.

Siegrist, M., Keller, C., Kastenholz, H., Frey, S., & Wiek, A. (2007a). Laypeople's and experts' perception of nanotechnology hazards. *Risk Analysis, 27*(1), 59-69.

Siegrist, M., Cousin, M., Kastenholz, H., & Wiek. (2007b). Public acceptance of nanotechnology foods and food packaging: The influence of affect and trust. *Appetite, 49*, 459-466.

Slovic, P. (1992). Perception of risk: reflections on the psychometric paradigm. InD. Golding and S. Krimsky (Eds.), *Social theories of risk* (pp. 117-52). Westport, CT: Praeger.

Slovic, P. (2000). *The perception of risk*. London: Earthscan Publications.

Slovic, P. (1999). Trust, emotion, sex, politics, and science: Surveying the risk-assessment battlefield. *Risk Analysis*, *19*(4), 689-701.

Slovic, P., Finucane, M., Peters, E., & MacGregor, M. (2004). Risk as analysis and risk as feelings: some thought about affect, reason, risk, and rationality. *Risk Analysis*, *24*(2), 1-12.

Tanaka, Y. (2004). Major psychological factors affecting acceptance of gene-recombination technology. *Risk Analysis, 24*(6), 1575-1583.

Taylor-Gooby, P. (2006). Social divisions of trust: Scepticism and democracy in the GM nation? Debate. *Journal of Risk Research, 9*(1), 75-95.

Townsend, E., & Campbell, S. (2004). Psychological determinants of willingness to taste and purchase genetically modified food. *Risk Analysis*, *24*(5), 1385-1393.

Townsend, E. (2006). Affective influences on risk perceptions of, and attitudes toward, genetically modified food. *Journal of Risk Research, 9*(2), 125-139.

Townsend, E., Clarke, D. D., & Travis, B. (2004). Effects of context and feelings on perceptions of genetically modified food. *Risk Analysis*, *24*(5), 1369-1384.

Verhoog, H. (2003). Naturalness and the genetic modification of animals. *Trends in Biotechnology, 21*(7), 294-297.

Wildavsky, A. (1987). Choosing preferences by constructing by institutions: A cultural theory of preference formation. *American Political Science Review, 81*(1), 3-21.