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The Effect of Ideology on Attitudes toward GM Food Safety among Chinese Internet Users

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Abstract: This study explores the causal relationship between Internet users' ideologies and their corresponding attitudes to genetically modified (GM) food safety. Using the 2015 Chinese Internet User Survey data ($N = 3780$) as a representative sample of Internet users from China, the study investigates factors influencing people's attitudes to GM food safety. Multinomial Logistic Regression Models are applied to examine the effects of demographic features (gender, age, education, family annual income, location, CPC membership, and occupation) and ideological factors (general ideology, political ideology, economic ideology, and cultural ideology) on attitudes to GM food safety. The results demonstrate that the percentage of people whose attitude is that "GM food is risky" (35.1%) surpasses those who think "GM food is safe" (20.4%). The young generation respondents think that GM food is safe, while those with higher levels of income and education are more inclined to view GM food as risky. In addition, public sector employees tend to think that GM food is risky. Respondents characterized with right-wing ideology in general tend to regard GM food as safe, compared to left-wing ideologists. However, their attitude varies in different ideological dimensions of politics, economics, and culture. This paper contributes new insights into understanding ideological influences on science development and sustainability.

Keywords: food safety; GM food; ideology; politics; economics; culture

1. Introduction

Genetic engineering is one of the most powerful 21st century technologies. In 1985, the genes from Bt (*Bacillus thuringiensis*) were inserted into the genetic sequences of tobacco plants, in order to make the plants insect-tolerant [1]. Gradually, several Bt genes were engineered and subsequently approved for use in crops like cotton, corn, mustard, and rice. These crops were then labelled as genetically modified (GM) foods [2,3].

The world's population is predicted to reach 10 billion by 2050. Therefore, increased yields will be needed to feed the increasing population, if a sustainable world is to be achieved. The goal of increased yields was considered to be the prime application when GM technology was first introduced [1,3–5]. It is estimated that, on average, between 15% and 20% of crop yield could be lost to animal pests worldwide. However, the actual losses caused by these pests were reduced to approximately 10%, because of the introduction of pest control measures [6]. However, in developing countries, the adverse effects of synthetic insecticides (particularly to human health) are still quite common, due to the use of older forms of chemistries, as well as laxity in the preparation, application, storage, and disposal of chemicals [7]. Today, GM technology enables crops to produce insecticidal proteins, which offers a means to control insects without the potential harmful effects caused by the misuse of synthetic insecticides [8]. Furthermore, GM technology can directly improve crop yields by accelerating growth rates, or increasing the size of the crop plant [1].

However, GM technology is also the subject of heated debate in relation to its effects on the environment and public health [2]. Some insist that GM technology could help address some of the major challenges to agriculture-based economies created by climate change, relieve the starving population, reduce energy and chemical inputs, and deliver more profits to farmers, which in turn, would contribute to the sustainable development of the human world [3,8–11]. Others, however, worry that GM technology could contaminate the environment, destroy ecological balances, exert side-effects on human health, and ultimately jeopardize the sustainable development of humanity [9,12,13].

The GM debate among consumers has been consistently presented as being contentious [14], and further characterised as being polarised into two main groups—those who are pro-GM and those who are anti-GM [15]. Consumer surveys regarding the acceptance of GM foods have been conducted in the EU and the U.S. since the early 1990s. The 2005 Eurobarometer survey shows that “GM food is widely seen as not being useful, as morally unacceptable and as a risk to society” [16]. In 2018, the International Food Information Council Foundation (IFIC) surveys found that nearly half of U.S. consumers avoid GM foods. A large majority of Americans say they oppose GM foods primarily because they are concerned about the human health impacts [17]. In Italy, Harrison et al. [18] reported that approximately half of Italian people do not consider GM foods to be ethically acceptable. The study found that Italian consumers are more sensitive to the potential risks that GM food may pose to human health and the environment, even compared to U.S. consumers. In China, researchers have conducted surveys to gauge the level of public awareness and acceptance of GM foods. For instance, Lv and Ma [19] conducted a series of surveys entitled “Chinese Public and Biotechnology”; the surveys were conducted in 2003, 2006, and 2009. The level of public awareness of GM foods was low in 2003 (16%), moderate in 2006 (57%), and high in 2009 (90%). Huang et al. [20] verified that two-thirds of urban residents have heard of GM foods. Huang and Peng [21] reports that the percentage of consumers who perceived GM food as unsafe for consumption increased by more than 30% in the 2002–2012 period. They explained that consumers’ attitudes were changing because of the increasing influence of negative media reports in recent years regarding GM technology.

Having the largest population (but a relatively limited quantity of arable land), China intends to use GM technology to improve agricultural productivity [22]. China has developed effective plant genetic transformation systems and established several national centres for plant genome research and GM crop testing [22]. In 2008, in addition to several national and provincial investments in agricultural biotechnology research projects (such as the “863” program and “973” program), a much larger government program was launched. This project aims to commercialize Chinese genetically engineered crops and livestock species and has a budget of CNY24 billion (US\$3.8 billion) over 12 years [10]. In 2009, China became the first country in the world to approve insect-resistant rice and high-phytase maize as safe for consumption and production [10,22].

However, in late 2008, in China, milk suppliers were discovered adding melamine to artificially boost the milk’s protein readings. This practice resulted in nearly 300,000 infants becoming sick, and six died, dramatically arousing the public’s awareness of food safety issues [23]. China’s decision to commercialize GM products even after the milk-tampering scandal may have induced an increase in opposition to GM-related activities [21]. Those opposing GM foods launched a series of anti-GM initiatives in the public media, and especially on the Internet, starting in early-2010 [21]. Further, GM food safety became one of the top 10 concerns in the Chinese consumer sector in 2013, and was listed among the top 10 keywords during the NPC (National People’s Congress) & CPPCC (Chinese People’s Political Consultative Conference) in 2014 [24]. In addition, in September 2013, a sensational debate—held on the Internet—over GM food safety was ignited. The main participants in the debate were Fang Zhouzi, who is an Internet celebrity and who supports GM food, and Cui Yongyuan, who is a well-known former CCTV (China Central Television) host who opposes GM food [25]. Subsequently, thousands of millions of bloggers, blog followers, and other Internet users participated in the GM food debate.

As of December 2017, the number of Internet users in China had reached 772 million [26], meaning that 55.8% of the Chinese population were Internet users. Meanwhile, in 2017, the number of Chinese E-commerce customers reached 533 million, generating a total online transaction of CNY29.16 trillion (US\$4.23 trillion) [27]. E-supermarket is one of the flagship stores of E-commerce giants (i.e., JD, Taobao, and Suning), and, on each single day, thousands of millions of food and drink items are listed for sale. Internet users including E-commerce customers, therefore, are the primary debaters, arguing online about the safety of GM foods in China.

Research into consumer attitudes to GM food has demonstrated that consumer acceptance is driven not only by perceptions of potential personal benefits and health effects [21], but also by concerns and beliefs, such as ethical, moral, and political considerations [10,28,29]. As it is the overall responsibility of the government to ensure food safety, their behaviour is very important to the development of public opinion about the GM food safety network. Many studies have pointed out that government policies [10,22], official behaviours [10], and administrative statements [24] could trigger intense discussion on GM food safety. For instance, in China, the massive amount of money being invested in the commercialization of GM products clearly indicates that the Chinese government is pro-GM food. In spite of this, the spike in the Internet activities of those who oppose GM foods is inconceivable when one considers the ideological administration in China.

In China, administrative politics are guided by socialist ideology, venerating Marxism-Leninism. (It is written in the very beginning of the Constitution of the Communist Party of China, which states that “The Communist Party of China uses Marxism–Leninism, Mao Zedong Thought, Deng Xiaoping Theory, the Theory of Three Represents, the Scientific Outlook on Development, and Xi Jinping Thought on Socialism with Chinese Characteristics for a New Era as its guides to action”.) [30]. According to socio-psychological theories, ideology is one of the most important factors that reflect people’s values and perceptions of policy and politics [31]. In political science, ideology is traditionally divided dichotomously; that is, into two groups, usually called “left vs. right”, or “conservative vs. liberal” [32,33]. Although certain distinct, well-acknowledged core aspects of left-right distinctions have been identified [33–35], in different societies, “left” and “right” carry meanings that vary in political, economic, and cultural conditions [36]. For example, Carney et al. [37] reviewed many studies on ideology and found that, in personal traits, left-wing ideologists in Western countries are usually open-minded, creative, desirous of novelty, uncontrolled, and imaginative. In contrast, right-wing ideologists tend to be nationalist, and in favour of a strong state.

In China, the debate between left and right ideologies was historically a sensitive core issue of political life, and in reality, Chinese administrative politics are generally considered to be left-wing ideology in nature [38]. In recent years, social science researchers have applied methods of multidisciplinary studies, such as literature reviews or questionnaire surveys, to analyse the status quo of left-right ideology in contemporary China [39,40]. For example, based on a national online survey, Pan and Xu [41] categorized Chinese ideologies into three dimensions, namely political, socio-economic, and nationalistic ideologies. Similarly, Le and Yang [42] categorized Chinese ideologies into three dimensions according to their Internet survey findings, which are political, cultural, and economic ideologies. These researchers found that there are clear left-right ideological preferences among Chinese Internet users.

As is well acknowledged by the Chinese government and academic scholars, online opinions are the source, hub and leading guide of public opinion for the whole of society [43,44]. A large volume of research has proved that online public opinion can exert significant influence over legislation, law enforcement, public administration, medical treatment, and environmental conservation [45–47]. If we look back in history, all too often we find that scientific progress and innovation have been blocked by ideologies [48].

Accordingly, with the extremely large number of Internet users who are willing to express their attitude towards GM food safety, public opinion could certainly be swayed, particularly with general regard to GM food safety in China. In the present study, we apply previous findings of left-right

ideologies and define the left ideology in China as indicating people who support “state power in politics, more government involvement in economics, and traditional Chinese culture”; while conversely, the right ideology in China prefers “individual rights and freedom, less government involvement in economics, and western culture”. This study aims to examine if there are cause-effect relationships (in terms of Internet users) between ideologies and attitudes towards GM food safety in China. Specifically, three dimensions of ideology (political, economic, and cultural ideologies) are applied to investigate such relationships.

2. Materials and Methods

2.1. Data Collection

We used an open database, the “2015 Chinese Internet User Survey” data to examine the cause-effect relationship between Internet users’ ideology and their attitude towards GM food safety. The database is part of the Chinese National Survey Data Archive, and is released by the Chinese General Social Survey Organization. Survey questionnaires were designed in Chinese [49,50]. In 2015, the survey was distributed through “Wen-juan” web (www.wenjuan.com) and Sina Weibo from July to August, 2015. Wen-juan web is a professional website for distributing academic and empirical surveys. Sina Weibo is the most popular microblog platform and online public opinion battlefield in China. People who access these two websites are considered to be active opinion givers on the Internet [50]. The reliability of answers to the survey was controlled by the following measures: (1) each IP address could only submit the questionnaire once; (2) the time taken to answer each questionnaire was calculated, and answers that took less than eight minutes were disregarded; (3) determining the truthfulness of answers was done by asking “How truthful were you when filling out the questionnaire?”. Ultimately, 3780 valid responses were collected. The reported truthfulness of answers was measured using ten categories, from 1 (low) to 10 (high). In this case, 69.0% of respondents reported a score of “10”, 26.2% reported “9” or “8”, and the remaining 2.5% reported scores of “7 to 1”. The respondents come from 32 out of 34 provincial regions in China (no responses were received from Tibet and Macao). In addition, 0.8% of the responses came from overseas (see Appendix A).

2.2. Measurements

2.2.1. Dependent Variable

Attitude to GM food safety was used as the dependent variable. In the survey, the question was asked as “regarding GM food, some people think it is risky, yet others believe it is safe. What is your opinion?”. The question had three possible answers: risky, safe, and don’t know (hereafter, ‘DK’).

2.2.2. Explanatory Variables

Previous studies have shown that demographic features are related to attitude towards GM food safety [9,21]. In the present study, demographic features were used as explanatory variables. For gender, male was coded as “1”, and female was “0”. For CPC membership, CPC member was coded as “1”, and non-CPC member was “0”. Age was a continuous variable ranging from 13 to 87 years old. The variable of education was measured by eight categories, ranging from less than primary school to graduate school. We recoded the education variable in five categories, with “1” representing less than primary school, “2” representing primary or secondary school, “3” as high school, “4” as undergraduate school, and “5” as graduate school. The variable of family annual income was measured by 12 categories, ranging from 0 to above two million CNY. We recoded it into five categories according to the 2015 real GDP per capita, which was CNY50,251 (US\$8211) [51], with “1” representing 0 to 40,000, “2” representing 40,000 above to 100,000, “3” as 100,000 above to 200,000, “4” as 200,000 above to 500,000, and “5” as above 500,000.

The variable of occupation is measured by 21 detailed items. According to the traditional division standard of the employment market in China, we recoded those 21 types of occupations into two categories: occupations in the public sector, and those in the non-public sector. Occupations in the public sector include bureaucrats, soldiers, state-owned enterprise employees, teachers, researchers, students, public hospital doctors, staff in CPC branch organizations (such as the Women's Federation, the Youth League, etc.) and journalists [52]. (Schools, research institutes, public hospitals, and the press (all traditional media and their news media branch) are owned by the government in China. Salaries of employees in these sectors are financed by national or provincial governments. Appointment of leaders in these sectors is also controlled by the governments.) Accordingly, occupations in the non-public sector include farmers, five types of private entrepreneurs and employees, lawyers, entertainment industry workers, NGO staff members, freelancers, the unemployed, and others. The variable of location was divided into six categories, i.e., village, town, small city, medium-sized city, large city, and overseas.

For variables of ideology, the present study uses a series of questions in the survey concerning the fundamental issues of politics, economics, and culture in contemporary China. Political ideology was investigated via 17 questions (P1–P17). Specifically, people who prefer social equality, sovereignty, nationalism, authoritarianism, Marxism-Leninism and socialism, and Maoists were identified as having a left-wing ideology. Economic ideology was investigated using four questions (E1–E4). People who prefer government involvement in markets, state ownership and control over property and other vital economic domains were identified as having a left-wing ideology. Cultural ideology was investigated via four questions (C1–C4). People who prefer traditional Chinese culture, while opposing premarital sex and homosexuality, were identified as having a left-wing ideology. General ideology was investigated by the results of these three dimensions of ideology. Answers to those three dimensions of ideology and the general ideology were assigned as the average value of answers to the related questions. For example, answer values with regard to political ideology were the average value of answers to those 17 questions (P1–P17).

The method of a five-point Likert scale was applied to measure respondents' opinions toward questions of ideology, from "strongly agree" (coded as "1") to "strongly disagree" (coded as "5"). The code of "6" represents "don't know" answers and was recorded as a missing value. Accordingly, the total number of respondents in the descriptive analysis was less than 3780. In the process of regression analysis, to reduce the loss of respondents' information, we applied the method of "linear trend at the point" to substitute missing values, and thus, the number of respondents was 3780. We conducted the test of reliability of attitude towards GM food safety and three ideological dimensions. The Cronbach's α value was 0.636 ($N = 3780$), indicating an acceptable model fit.

2.3. Data Analysis Strategy

Logistic regression models were applied to analyse the cause-effect relationships between attitudes towards GM food safety and ideology. Tests of model assumptions were conducted using the Multinomial Logistic Regression Model. The analysis was processed by IBM SPSS 23.

3. Results

A total of 3780 respondents were used for analysis. Results of the descriptive analysis and regression analysis are presented in this section.

3.1. Descriptive Analysis

3.1.1. Demographic Features

Descriptive analyses of respondents' demographic characteristics and ideology are presented in Table 1. Out of all 3780 respondents, 35.1% thought GM food was risky, 20.4% thought GM food was safe, and 44.5% answered "DK". The age of respondents ranged from 13 to 87 years old ($M = 34.15$,

$SD = 10.84$). For gender distribution, 2643 (69.9%) were male, and 1137 (30.1%) were female. Regarding CPC membership, 972 respondents (25.7%) were CPC members, compared to 2808 (74.3%) non-CPC members. In terms of annual family income, 812 families (21.5%) earned no more than CNY40,000; 1118 families (29.6%) earned CNY40,000 to 100,000; 1052 families (27.8%) earned CNY100,000 to 200,000; 586 families (15.5%) earned CNY200,000 to 500,000, and 212 families (5.6%) earned more than CNY500,000. For the variable of occupation, 1531 respondents (40.5%) were public sector employees, and 2249 (59.5%) of them were non-public sector employees. Regarding location, almost half of the respondents were living in large cities (48.8%), compared to 6.7% who lived in a town or village. Regarding education, only 3.0% of respondents were below the level of secondary school, while the majority (67.8%) had undergraduate diplomas.

Table 1. Descriptive analysis of attitudes to GM food safety and ideology.

	Frequency (N)	Percent (%)			
Attitude towards GM Food Safety					
Risk	1325	35.1			
Safe	772	20.4			
DK	1683	44.5			
Gender					
Male	2643	69.9			
Female	1137	30.1			
CPC Membership					
Yes	972	25.7			
No	2808	74.3			
Annul Family Income (CNY)					
<40,000	812	21.5			
40,000 to 100,000	1118	29.6			
100,000 to 200,000	1052	27.8			
200,000 to 500,000	586	15.5			
>500,000	212	5.6			
Occupation					
Public sector	1531	40.5			
Non-public sector	2249	59.5			
Location					
Village	117	3.1			
Town	135	3.6			
Small city	667	17.6			
Medium-sized city	987	26.1			
Large city	1843	48.8			
Overseas	31	0.8			
Education					
Less than primary school	5	0.1			
Primary or secondary school	111	2.9			
High school	346	9.2			
Undergraduate school	2562	67.8			
Graduate school	756	20			
	<i>N</i>	<i>Mean</i>	<i>SD</i>	<i>Min.</i>	<i>Max.</i>
Age	3780	34.15	10.84	13	87
Political Ideology					
P1 Individual's benefit must subordinate to the state's.	3743	3.28	1.34	1	5
P2 Territorial and trade conflicts are provoked by other countries.	3595	3.18	1.16	1	5
P3 The central government should get Taiwan back by force if necessary.	3729	3.64	1.37	1	5
P4 Patriots must boycott Japanese goods.	3761	3.92	1.22	1	5

Table 1. Cont.

P5 Hostile forces abroad, which account for most of China's troubles, want to subvert China.	3703	3.47	1.39	1	5
P6 China should be tough on territorial disputes.	3681	2.86	1.2	1	5
P7 No criticism of China by teachers should be allowed in class.	3753	3.81	1.24	1	5
P8 Free speech, association and demonstration should be controlled.	3764	4.18	0.94	1	5
P9 Press censorship is necessary.	3759	3.48	1.35	1	5
P10 We should narrow the gap of wealth and build a society of equal rights for everyone.	3761	1.92	0.98	1	5
P11 I feel solemn when the national flag is raised.	3683	2.48	1.18	1	5
P12 Sovereignty outweighs human rights.	3727	3.85	1.11	1	5
P13 Mao's great contribution overshadows his errors.	3727	3.64	1.32	1	5
P14 There is no such thing as universal values such as freedom, democracy and human rights.	3708	3.72	1.26	1	5
P15 China should not implement electoral democracy, because it's a fake democracy.	3715	3.9	1.09	1	5
P16 China should adhere to Maoism and socialism.	3693	3.35	1.39	1	5
P17 We should harshly punish those who challenge authority.	3742	3.4	1.34	1	5
Economic Ideology	3780	3.18	0.63	1	5
E1 Land-related property rights should be owned by the state or collectives, not individuals.	3679	3.81	1.09	1	5
E2 Businesses related to national security and any other vital economic domains must be run by a state-owned company.	3719	3.39	1.23	1	5
E3 It's much better for the government to intervene more in the market.	3733	3.7	1.04	1	5
E4 The government should guarantee basic living standards for low-income citizens.	3761	1.83	0.83	1	5
Cultural Ideology	3780	3.39	0.62	1	5
C1 We should respect Confucian culture and Chinese conventions.	3750	2.71	1.09	1	5
C2 Homosexual marriage should not be protected by law in the same way as heterosexual marriage.	3731	3.65	1.08	1	5
C3 No premarital sex should be allowed.	3748	3.45	1.12	1	5
C4 I trust the Eight Diagrams & Feng-shui.	3697	3.75	1.01	1	5
General Ideology	3780	3.33	0.59	1.58	5

Notes: *SD* = Standard Deviation.

3.1.2. Characteristics of Ideology

Variables of general ideology, political, economic, and cultural ideologies are continuous variables. As displayed in Table 1, the general ideology variable has a mean value of 3.33 ($SD = 0.59$), indicating that respondents had moderately right-wing ideology. The political ideology has a mean value of $M = 3.42$ ($SD = 0.91$), the economic ideology has a mean of 3.18 ($SD = 0.63$), and the cultural ideology has a mean of 3.39 ($SD = 0.62$). Specifically, radical right-wing ideology was seen in opinions relating to the political issues of "Free speech, association and demonstration should be controlled" ($M = 4.18$, $SD = 0.94$). Radical left-wing ideology was seen on opinions about political issues of "We should narrow the gap of wealth and build a society of equal rights for everyone" ($M = 1.92$, $SD = 0.98$), and opinions about economic issues of "The government should guarantee basic living standards for low incomes" ($M = 1.83$, $SD = 0.83$).

3.2. Relationship between Attitudes to GM Food Safety and Ideology

Two types of logistic regression models were constructed to explore cause-effect relationships between attitudes to GM food safety and ideology. The first model is made up of a total of nine variables,

including attitudes to GM food safety, general ideology, and demographic variables. The second model is made up of a total of four variables, namely attitudes to GM food safety, political ideology, economic ideology, and cultural ideology. Regarding the first model, model fitting information shows that the Chi-square is 320.194 ($p = 0.000$). Goodness-of-fit shows that the Chi-square is 7530.816 ($p = 0.411$). For the second model, model fitting information shows that the Chi-square is 242.661 ($p = 0.000$). Goodness-of-fit shows that the Chi-square is 4966.445 ($p = 0.318$). These results indicate that those two models demonstrate a good model fit [53]. Results of these two logistic regressions are presented in Tables 2 and 3.

Table 2 shows that, although CPC membership and location do not have a significant effect, other variables (age, gender, family annual income, occupation, education, political ideology, economic ideology, cultural ideology, and general ideology) have a significant influence on Internet users' attitudes to GM food safety.

Table 3 shows the results of parameter estimates of the two logistic regression models when both models took answers of "GM food is safe" as a reference category. Regarding the age variable, with a one-year increase in age, there is a 1.04 times stronger tendency for respondents to believe that GM food is risky ($p < 0.001$), and 1.02 times stronger tendency for respondents to answer DK ($p < 0.001$). For gender, females are inclined to answer DK ($p < 0.05$). Regarding family annual income, people whose family earns CNY40,000 to 100,000 a year have the strongest tendency to believe that GM food is risky ($p < 0.001$), while people whose family earn no more than CNY40,000 a year have the strongest tendency to answer DK ($p < 0.001$). For occupation, people who work in the public sector have a stronger tendency to believe that GM food is risky ($p < 0.001$), and are also inclined to answer DK ($p < 0.05$). Regarding education, people who only finished primary or secondary school have the strongest tendency to believe that GM food is risky ($p < 0.001$), and are also inclined to answer DK ($p < 0.01$).

Regarding ideological variables, respondents who have left-wing ideology in general tend to believe that GM food is risky ($p < 0.001$), and also tend to answer DK ($p < 0.01$). Specifically, respondents with left-wing ideology in political issues show a strong tendency to answer safe ($p < 0.001$). However, respondents with a right-wing ideology in terms of economic issues are more likely to believe that GM food is risky ($p < 0.001$). Respondents who have a left-wing ideology in terms of cultural issues are prone to regard GM food as risky ($p < 0.001$) and are also inclined to answer DK ($p < 0.001$). An illustration of the relationships between attitudes to GM food safety and ideologies can be seen in Appendix B.

Table 2. Likelihood ratio tests between attitude to GM food safety and variables ($N = 3780$).

	Chi-Square	df	Sig.
Age	79.279	2	0.000 ***
Gender	6.476	2	0.039 *
CPC membership	1.258	2	0.533
Family annual income	28.126	8	0.000 ***
Occupation	25.067	2	0.000 ***
Location	15.231	10	0.124
Education	44.276	8	0.000 ***
Political ideology	52.649	2	0.000 ***
Economic ideology	42.859	2	0.000 ***
Cultural ideology	148.241	2	0.000 ***
General ideology	87.278	2	0.000 ***

Notes: * $p < 0.05$, *** $p < 0.001$.

Table 3. Parameter estimates of logistic regression ($N = 3780$).

	<i>B</i>	<i>SE</i>	<i>Wald</i>	<i>Exp (B)</i>
Risky (Safe as Reference)				
Age	0.042	0.005	73.169	1.043 ***
Gender (Female as reference)				
Male	−0.187	0.109	2.942	0.829
CPC membership (Non-CPC member as reference)				
CPC member	−0.096	0.114	0.722	0.908
Family annual income (CNY) (Above 500,000 as reference)				
0–40,000	0.752	0.220	11.722	2.121 ***
40,000–100,000	0.816	0.212	14.811	2.262 ***
100,000–200,000	0.456	0.207	4.842	1.578 *
200,000–500,000	0.437	0.217	4.064	1.549 *
Occupation (Occupation in non-public sector as reference)				
Occupation in public sector	0.497	0.104	23.045	1.644 ***
Living area (Overseas as reference)				
Village	−0.005	0.641	0.000	0.995
Town	−0.294	0.621	0.225	0.745
Small city	0.263	0.579	0.207	1.301
Medium-sized city	−0.099	0.571	0.030	0.906
Large city	−0.139	0.567	0.060	0.870
Education (Graduate school as reference)				
Less than primary school	0.940	1.249	0.566	2.560
Primary or secondary school	2.181	0.543	16.120	8.856 ***
High school	0.584	0.212	7.591	1.793 **
Undergraduate school	0.295	0.130	5.186	1.343 *
Political ideology	−0.137	0.075	3.332	0.872
Economic ideology	0.428	0.102	17.487	1.534 ***
Cultural ideology	−1.053	0.089	139.612	0.349 ***
General ideology	−0.727	0.086	71.602	0.484 ***
DK (Safe as Reference)				
Age	0.023	0.005	24.233	1.023 ***
Gender (Female as reference)				
Male	−0.259	0.102	6.393	0.772 *
CPC membership (Non-CPC member as reference)				
CPC member	−0.118	0.106	1.236	0.889
Family annual income (CNY) (Above 500,000 as reference)				
0–40,000	0.692	0.200	11.981	1.997 ***
40,000–100,000	0.668	0.193	11.966	1.950 ***
100,000–200,000	0.515	0.187	7.601	1.674 **
200,000–500,000	0.269	0.197	1.857	1.308
Occupation (Occupation in non-public sector as reference)				
Occupation in public sector	0.199	0.096	4.248	1.220 *
Living area (Overseas as reference)				
Village	−0.156	0.543	0.082	0.856
Town	−0.328	0.521	0.396	0.721
Small city	−0.027	0.479	0.003	0.974
Medium-sized city	−0.467	0.471	0.985	0.627
Large city	−0.386	0.466	0.687	0.680
Education (Graduate school as reference)				
Less than primary school	−0.173	1.240	0.019	0.841
Primary or Secondary school	1.481	0.537	7.605	4.397 **
High school	−0.069	0.199	0.121	0.933
Undergraduate school	−0.184	0.114	2.622	0.832
Political ideology	0.288	0.073	15.645	1.334 ***
Economic ideology	−0.101	0.096	1.122	0.904
Cultural ideology	−0.666	0.083	64.979	0.514 ***
General ideology	−0.234	0.080	8.504	0.792 **

Notes: “GM food is safe” was used as reference category of the dependent variable; *B*, estimated multinomial logistic regression coefficients for the models; *SE*, standard errors; * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

4. Discussion

A total of 3780 respondents were used in the analysis. The study found that 35.1% of respondents think that GM food is risky, which is more than those who believe that GM food is safe (20.4%). This result is consistent with previous studies. With data comparison among several surveys on attitude to GM food safety in China, Huang and Peng [21] found that the percentage of consumers who perceived GM food as risky increased by more than 30% in the 2002–2012 period. Major shifts occurred after 2010, when the percentage of “GM food is risky” surpassed that of “GM food is safe”. These changes might be due to the increasing influence of negative media reports on GM technology. It was also noted that the 2010–2013 period was a sensitive time for the Chinese administration, and therefore, scientists and bureaucrats did not challenge media attacks on GM food [10].

Frewer et al. [54] found that, in studies aimed at understanding consumers’ attitudes to GM food safety, demographic information is frequently reported in terms of sample characteristics, but is rarely used as an explanatory variable. In the present study, we construct the first model to explore the effect of demographic features on attitudes to GM food safety. For the age variable, young people tend to view GM food as safe, which is in line with previous study findings [55]. This might be explained by the fact that, compared to older people, young people are more often risk-takers and keen for new technologies [56]. For the variable of occupation, respondents who work in the public sector are inclined to think that GM food is risky. This might be because, in Chinese society in general, the majority of employees in the public sector have a high level of education and left-wing ideology. As left-wingers are conservative in respect to novelty [42], public sector employees are inclined to think GM food is risky.

Regarding the variable of family annual income, we found that, compared to people whose family earns more than CNY500,000, people all tend to think GM food is risky if their family’s annual income is near the top of the income range (CNY0–40,000; 40,000–100,000; 100,000–200,000; 200,000–500,000). One explanation for this finding might be that a higher level of income may translate into a search for health food and, in general, GM food does not correspond to this perception [55]. Specifically, people whose family earns CNY40,000 to 100,000 have the strongest tendency to believe GM food is risky, compared to people from families of other income ranges. When considering the income standard of 2015 in real GDP per capita (CNY50,251), families earning CNY40,000 to 100,000 could be categorized as middle-class families. This speculation is supported by results of cross-tables of family annual income and education (see Appendix C). We found that the number of respondents who have an undergraduate diploma was the highest in families with annual earnings of CNY40,000 to 100,000. In addition, for people whose family earn CNY40,000 to 100,000, the number of respondents who have diplomas of primary, secondary, and high school ranked in the second place in those five income ranges. Thus, the effect of the family’s annual income on attitude towards GM food safety might be largely influenced by respondents’ education levels.

Regarding the variable of education, we found that, in contrast to people who have less than a primary school education, people who received formal education diplomas all tended to think GM food is risky. However, people who received higher education, such as undergraduate school, have a weaker tendency to regard GM food as risky, compared to those with lower levels of education. Similar findings have been pointed out by Hester and Gerda [57], and Rodríguez-Entrena, Salazar-Ordóñez and Sayadi [55], who reported that more knowledge of GM technology leads to more tolerance of GM food consumption. People who had a diploma from primary or secondary school showed the strongest tendency to believe GM food is risky, and also tended to answer DK. The explanation might be that, on one hand, primary or secondary school education cannot provide enough information on GM food; on the other hand, people with such education can be easily influenced by the opinions of entertainment stars (e.g., Cui Yongyuan), rather than scientific evidence.

Regarding ideology, results of descriptive analysis of ideology show that, generally, respondents have a moderately right-wing ideology ($M = 3.33$). This finding is in accordance with what Pan and Xu [41] found about the ideological positions of Chinese Internet users. The regression analysis results

show that both general ideology and the three ideological dimensions have a significant influence on attitudes to GM food safety. These results are in line with previous studies, which state that scientific problems are not solely about science, but are entangled with ideological issues [58,59]. Our findings show that respondents characterized as having a right-wing ideology, in general, tended to regard GM food as safe, compared with those with a left-wing ideology. Similarly, respondents who had a right-wing ideology in the cultural dimension think GM food is safe. This can be explained by the fact that right-wingers in China are usually people who are open-minded, creative, curious, and novelty-seeking [37]; they are not overly restricted by the traditional culture, like Confucianism. As GM food is produced using advanced genetic engineering technologies, right-wingers might have gained more knowledge about GM food, and thus show a friendly and welcoming attitude towards it, compared with left-wingers. In contrast, respondents with a left-wing ideology are more likely to consider GM food as risky. Left-wingers in China are represented by people who oppose capitalism, resist western modern values, yet acknowledge the great contribution of Mao Zedong to China, and support strong and powerful authoritarianism [60]. Thus, our findings can be explained by left-wingers resisting the products of Western technologies, so they regard GM food as risky.

Nevertheless, respondents with right-wing ideology in political issues showed a strong tendency to answer DK. This can be explained from a political perspective. It is a fact that China approved insect-resistant rice and high-phytase maize as safe for consumption and production, but the government did not make a public announcement [10,22]. Right-wingers in China prefer individual rights and freedom, and less government involvement in economics. Low political involvement on the part of right-wingers might be the reason why right-wingers in political issues showed a strong tendency to answer DK. What's more, we found that respondents with right-wing ideology in economic issues are more likely to believe that GM food is risky. This is easy to understand because people who have a higher family annual income also showed a strong tendency to regard GM food as risky.

Another possible explanation can be made from the perspective of media influence. Media researchers suggest and have proved in different ways that people selectively expose themselves to certain media contents according to their inherent preference and interests; for example, those searching for political information prefer to watch news, while those searching for social interaction are more in favour of using social media [61–63]. In addition, it has been proved that trust in the media positively affects people's attitudes toward new technologies, genetic engineering and other social issues [64]. Therefore, it is plain to understand why left-wingers in political and economic issues feel safe about GM food. Left is the official ideology of the CCP and certainly the "tongue of CCP"—mainstream media, whether traditional or new social media, are promulgating the official point of view. The Chinese government and mainstream media, like People's Daily and CCTV, once strongly promoted GM food [65] and, after the hot debates between Fang and Cui, which revealed more negative influences of GM food, the mainstream media still hold a relatively neutral or even moderately 'pro' position on GM food. Left-wing Internet users who are involved in political issues, those who trust the national voice, are unsurprisingly inclined to regard GM foods as safe.

As discussed above, we found that the effect of ideology on attitude towards GM food safety was not consistent, but varied in different ideological dimensions. Take right-wingers for example, we found that right-wingers in the cultural dimension view GM food as safe; right-wingers in the economic dimension view GM food as risky; those with a right-wing ideology in the political dimension tend to answer DK. This is a heuristic finding, which indicates that the effect of ideology on GM food safety should be examined from different aspects of ideology. This conclusion reflects the fact that attitudes toward GM food safety should be investigated from multidimensional perspectives.

The limitation of this study is in the research design. Since we use secondary data, which means that data were collected by other scholars, and since GM food safety was only one part of the data collection efforts, some issues of GM food safety, like GM food consumption, were not included. Future studies with specific designs for GM food safety and ideology could remedy this. Further discussion

is also needed on cause-effect relationships between ideology and attitude to GM food in concrete political, economic and cultural contexts.

5. Conclusions

This paper contributes to the current understanding of attitudes toward GM food safety in China in three important ways. First, we extend understanding beyond the existing literature, which usually treats demographic features as sample characteristics. Our study shows that the individual features of age, gender, family annual income, occupation, and education have significant effects on attitudes to GM food safety. Secondly, we provide new insights into the underlying determinants of attitudes to GM food safety by differentiating ideological dimensions. We examine the three ideological dimensions of politics, economics, and culture. We find that individuals who hold right-wing ideologies, in general, tend to view GM food as safe, while those right-wingers' attitudes to GM food safety vary in different ideological dimensions. Thirdly, this study advances the present knowledge regarding the impact of ideology on scientific development among contemporary Internet users in China. Up to now, very few studies have paid attention to the effect of ideology on attitudes to GM food safety. This study makes a pioneering challenge and provides empirical evidence for this important topic. These findings can help researchers and policy-makers to shed more light on the ideological influences on scientific development and the sustainability of the human world, rather than simply being restricted to discussions in the scientific domain.

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Appendix A

Table A1. Distribution of Places of Respondents' Residence ($N = 3780$).

	Frequency	Percent (%)
Beijing	440	11.6
Tianjin	111	2.9
Shanghai	387	10.2
Chongqing	82	2.2
Hebei	110	2.9
Shanxi	75	2.0
Liaoning	123	3.3
Jilin	43	1.1
Henan	141	3.7
Jiangsu	290	7.7
Zhejiang	249	6.6
Anhui	104	2.8
Fujian	83	2.2
Jiangxi	58	1.5
Shandong	248	6.6
Heilongjiang	47	1.2
Hunan	93	2.5
Hubei	144	3.8
Guangdong	455	12.0
Hainan	15	0.4
Sichuan	159	4.2
Guizhou	17	0.4
Yunnan	42	1.1
Shaanxi	95	2.5

Table A1. Cont.

	Frequency	Percent (%)
Gansu	22	0.6
Qinghai	4	0.1
Inner Mongolia	28	0.7
Guangxi	46	1.2
Ningxia	9	0.2
Xinjiang	21	0.6
Taiwan	2	0.1
Hong Kong	6	0.2
Overseas	31	0.8
Total	3780	100.0

Appendix B

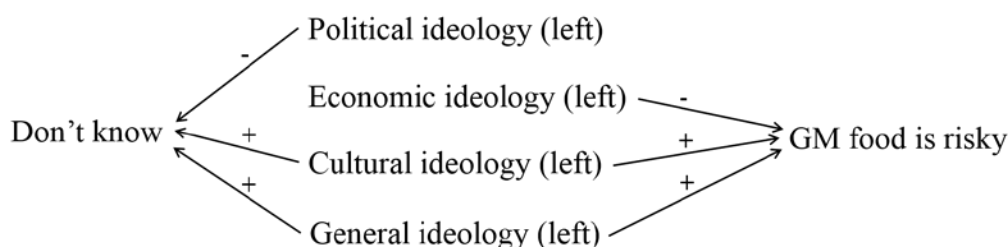


Figure A1. Illustration of Relationships between Attitudes to GM Food Safety and Ideologies.

Appendix C

Table A2. Cross Table of Education and Family Annual Income (N = 3780).

		0–40,000	40,000–100,000	100,000–200,000	200,000–500,000	Above 500,000	Total
Less than primary school	Count	3	1	0	1	0	5
	% of Total	0.1%	0.0%	0.0%	0.0%	0.0%	0.1%
Primary or secondary school	Count	52	36	16	5	2	111
	% of Total	1.4%	1.0%	0.4%	0.1%	0.1%	2.9%
High school	Count	136	125	53	23	9	346
	% of Total	3.6%	3.3%	1.4%	0.6%	0.2%	9.2%
Undergraduate school	Count	493	797	747	397	128	2562
	% of Total	13.0%	21.1%	19.8%	10.5%	3.4%	67.8%
Graduate school	Count	128	159	236	160	73	756
	% of Total	3.4%	4.2%	6.2%	4.2%	1.9%	20.0%
Total	Count	812	1118	1052	586	212	3780
	% of Total	21.5%	29.6%	27.8%	15.5%	5.6%	100.0%

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