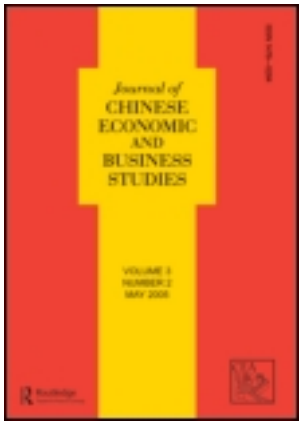

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Consumers' trust in government and their attitudes towards genetically modified food: empirical evidence from China

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Consumers' trust in government and their attitudes towards genetically modified food: empirical evidence from China

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Understanding the determinants of consumers' acceptance towards genetically modified food (GMF) is critically important for the biotechnology industry. Based on a unique data set collected by the authors in 2002 and 2003 in 11 cities of China, an econometric model of consumers' acceptance of GMF is estimated. The results show that consumers' acceptance of GMF is high in urban China and consumers' trust in government has a significantly positive effect on consumers' acceptance of GMF. Our study also shows that failure to consider the endogeneity of consumers' trust in government will lead to serious underestimation of its impacts on consumers' acceptance of GMF. This is, to the best of our knowledge, the first study on the impact of consumers' trust in government with consideration of the endogenous problems that often are encountered in consumer perception studies.

Keywords: trust in government; genetically modified food; consumers' attitude; China

JEL Classifications: Q13; Q18; O13

1. Introduction

Despite the potentially large benefits of agricultural biotechnology in boosting agricultural productivity, its applications have faced great challenges in recent years. One of the biggest challenges is consumers' perception and acceptance of genetically modified food (GMF). Recent studies show that many consumers concerned had negative opinions about GMF (Macer 2001; Lusk, Roosen, and Fox 2003, Gaskell et al. 2006). The public concerns and worldwide debates on GMF have affected agricultural biotechnology investment and the industry (Marchant, Fang, and Song 2003). Several major US and European food manufacturers and retailers have declared that they would accept only non-GM crops. Various strict regulations on GMF commercialization and marketing, such as regulatory approvals for domestic release, market segregation, and labelling to separate GMF from non-GMF, in many developed and developing countries, further fuel this challenge. Overall, the

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current public prospect for agricultural biotechnology seems to contrast with its promise a few years ago (Huang, Pray, and Scott 2002a; Huang et al. 2002b; Qaim and Zil 2003; Christoph, Bruhn, and Roosen 2008).

Understanding consumers attitudes towards and factors influencing their acceptance of GMF is critical for agricultural biotechnology development in the future. Studies in the EU and Japan have shown that most consumers' attitudes toward GMF in these countries were negative (Hoban 1996; Grimsrud et al. 2003; McCluskey, Grimsrud, and Wahl 2004; Gaskell et al. 2006; Costa-Font, Gil, and Traill 2008). For example, Grimsrud et al. (2003) found that consumers in Norway are willing to buy bread made with GM wheat only if the GM bread price is 49.5% lower than that of non-GM bread. According to a worldwide survey by European Commission in last several years, although European consumers' support for GM food products recovered in recent years, 58% of European consumers still feel pessimistic about GM food, and only 27% of European consumers feel optimistic about GM food (Gaskell et al. 2006). Other studies show more acceptance of GMF by consumers in the US and many developing countries, normally ranging from 60% to 80% depending on commodities and countries (Hallman et al. 2002, 2003; IFIC 2004; Huang et al. 2006; Lin et al. 2006).

The existing literature indicates that many factors may affect consumers' acceptance of GMF. In nearly all studies, income seems to be one of the major factors that is negatively associated with consumers' acceptance of GMF, and has been used to explain the generally higher acceptance rate in developing countries than in developed countries (Bredahl 2001; FAO 2004; Lin et al. 2006). Variations in the perception of GMF within the same income category across countries (e.g., between Europe and the US or among developing countries) are often hypothesized to be the effects of consumers' trust in government's ability to manage GMF, consumers knowledge to GM food, consumers' individual characteristics, and the nature of debates in the media (Gaskell et al. 1999; Moon and Balasubramanian 2004; Dean and Shepherd 2006).

The likely impacts of consumers' trust in government's ability to manage GMF on their attitudes towards GMF have received increasing attention since the late 1990s.[1] 'Trust in government' refers to people's willingness to rely on government in the management of risks (Earle and Cvetkovich 1995). Such trust in regulators is likely to be particularly important if the public perceive that they have no control over an uncertainty event, but must confer responsibility for ensuring their protection onto others – as arguably is the case with GM foods (Frewer et al. 2004). Gaskell et al. (1999) argued that consumers' trust in government could substitute for their knowledge about GMF, which might partly explain the relatively higher acceptance of GMF by consumers in the US compared with those in the EU. Several other studies in the EU and US also pointed out that trust in government could play an important role in shaping public attitudes towards GMF, largely via its links to risk perceptions (Curtis, McCluskey, and Wahl 2004; Hossain and Onyango 2004; Moon and Balasubramanian 2004). Based on a consumer survey in Beijing city, Curtis, McCluskey, and Wahl (2004) argued that Chinese consumers were found to be trusting of government regulators concerning the safety of food supply, which can partly explain why Chinese consumers are more supportive for GM food than most other developing and developed countries. A study in Taiwan also showed

that consumers who feel trust in the institutions and scientists performing gene manipulation have a high acceptance to GM food (Chen and Li 2007). Recent studies in China also confirmed a positive relationship between consumers' trust in government's public management ability and consumers' acceptance of GMF (Lin et al. 2006).

While the positive impacts of consumers' trust in government on consumers' acceptance of GMF is a plausible hypothesis, their empirical testing is problematic as one often encounters many difficulties in dealing with the endogeneity problem of the issues under investigation. Most existing empirical studies on this issue were based on the correlation analysis between consumers' acceptance to GMF and their trust in government. To the best of our knowledge, no article using multiple regression analysis with consideration of the endogeneity problem has been published yet. Whether or not and to what extent the positive relationship between of consumers' trust in government and consumers' attitudes on GMF reflects the true impact of the former on the latter is an issue needing further investigation. For example, the food regulations issued by government and some incidents, such as the mad cow disease crisis, can affect both the consumers' attitudes towards GMF and their trust in government management. Empirical estimation of the impacts of consumers' trust in government would be biased and inconsistent if one did not appropriately consider the endogeneity problem (Wooldridge 2002).

China is an interesting case for several reasons. China is the world's most populous nation and has been one of the world's leaders in promoting agricultural biotechnology research through public investment (Huang, Pray, and Scott 2002a). In 2008, the Chinese government approved a new GM Crops and Livestock Initiative with more than $3.5 billion on genetically modified crops and livestock research (Stone 2008). However, China has only approved two food crops, pepper and tomato, for commercialization production by the end of 2008, and even these two GM vegetables are still under development, and can hardly be found in markets. GM soybean oil is almost the only GM food product that is provided by supermarkets, and most of the GM soybean was imported from United Stated and Brazil. In 2002, the Chinese government issued the regulation requiring that all GM foods must to be labelled. China's final decision on whether it should commercialize GM rice is still under debate (Huang et al. 2005). Two main factors are affecting China's government decision on this: one is the worry about Chinese consumers' acceptance to GM rice, and the other is whether it will have a large negative impact on China's rice exports. Another reason making China an interesting case for study is the difference of China's political system in comparison with western countries. Because of this difference, it is academically attractive to look at whether the existing theories and empirical results on trust in government (e.g. impact of trust in government on consumers' acceptance to GM food) are applicable to China.

The overall goals of this study are to have a better understanding of consumers' attitudes towards GMF and empirically quantify the impact of consumers' trust in government on their attitudes towards GMF in China. The analysis is based on a unique data set with respondents randomly selected from 11 cities in China in 2002 and 2003.

This paper is organized as the follows. In the next section the data collection process and the samples are described. Statistical analysis of Chinese consumers'

attitudes towards GMF and consumers' trust in government are discussed in the third section. The fourth section presents the models and the results of empirical estimations. Several concluding remarks are provided in the final section.

2. Data and sample description

2.1. *Data*

The sample used in this study is a subset of the Urban Household Income and Expenditure Survey (UHIE) conducted by the National Bureau of Statistics of China (NBSC). NBSC's UHIE covers 226 cities across China with about 250,000 randomly selected households, which well represent China's urban consumers. These data have been serviced as the official source of information on the urban income and expenditure and have been widely used by scholars for various empirical studies. Normally, NBSC replaces about one third of its sample each year.

Our surveys were conducted in 11 cities under NBSC's UHIE survey in North and East China, which account for about 40% of the national population and nearly half of China's urban residents. Within each of the North and East regions, we applied a stratified random sampling approach to further select our survey areas from UHIE's sample cities to make sure that our samples well represent urban consumers in the two regions. Two large, three medium and six small cities were selected.[2] The number of samples under NBSC's UHIE survey in these 11 cities totalled 2300.

We conducted two rounds of surveys, one in 2002 and the second in 2003. In 2002, we randomly selected 1005 individuals from 2300 UHIES's samples in 11 cities for in-person and in-house interviews.[3] To avoid potential selection bias in the individuals interviewed in each household, the enumerators were asked to interview an adult (ages 16 to 70) whom they met first when they came to the interviewee's apartment. The interviews were conducted by the authors and professional enumerators from each provincial branch of NBSC. In 2003, we went back the same cities to repeat the survey with additional questionnaires on several key instrument variables used in this study.[4] Because NBSC replaces one-third of its UHIE samples each year, we were able to interview only 666 individuals who were interviewed in 2002 and another 334 new households randomly selected from UHIES's new samples in the same cities in 2003.[5] Because our survey in 2002 did not include the key instrumental variables designed to deal with the endogeneity problem of consumers' trust in government, the total samples used in this study are 666 from the first round survey in 2002 and 1000 from the second round survey in 2003. Huang et al. (2006) showed that there were no statistically significant differences in all variables between our samples and all samples under NSBC's UHIES in 2002 and 2003 in the 11 cities used in this study.

2.2. *Sample description*

The surveyed interviewees seemed to represent well the urban households in the study areas. The average family size in the sampled households was three persons (Table 1), which is identical to the average family size in North and East China where we conducted the survey (NBSC 2003). On average, per capita monthly income was 914 yuan in our sample and the corresponding figure was 918 yuan in the regions

Table 1. Description of respondents' individual and family characteristics.

	Means			T test[3]
	Average	2002	2003	$H_{2002}=H_{2003}$
Respondents' individual characteristics				
Share of male (%)	43	41	44	−1.21
Age (years)	47	46	47	−1.58
Education (years)	11	11	11	0
Occupation (%)				
Government	23	24	23	0.48
Enterprises	39	40	38	0.86
All others[1]	38	36	39	−1.36
Family characteristics				
Family size	3	3	3	0
Monthly per capita income (yuan)[2]	914	841	962	−5.39***
Residential cities (%):				
Small city	30	30	30	0
Medium city	31	32	30	0.87
Big city	39	38	40	−0.81
Has food allergic family member (%)	11	10	12	−1.29
Has children under 10 years old (%)	19	20	18	1.01

Notes: [1]Consumer price index was used to deflate the nominal income (base year is 2002).
[2]All others include retired, unemployment people, and all others.
[3]Mean difference by T test statistically significant at 1% (***).

(NBSC 2004). Our sample slightly favored females. Males accounted for 43 percent (1th row, Table 1). A higher share of females in the sample better represents aggregate consumer behavior because women normally play a larger role in family food shopping. Consumers working in the government sector accounted for about one fifth of the total sample. Nearly 40% of consumers in the samples worked in commercial enterprises. About 10% of the families in the sample have experienced food allergies and 20% of the interviewees have children younger than 10 years old.

Table 1 also shows no significant differences between the interviewee samples in 2002 and 2003 in all variables examined except for per capita income (last column of Table 1). The consumers' education, family size and distribution among different level of cities are almost identical in the two rounds of the survey. The income difference between 2002 and 2003 samples is 14%, which is similar to the national per capita income growth rate in urban areas (13%, NSBC 2004). Since the development of eastern and costal areas of China is faster than other regions, our survey results on per capita income growth seem reasonable.

3. Consumers' acceptance of GMFs and their trust in government

3.1. *Consumers' attitudes towards GMFs*

On average, more than 60% of consumers in urban China accepted GMFs, while the consumers opposing GMFs accounted for only about 7% (last row, Table 2).

Table 2. Consumers' acceptance towards the specific GM foods (%).

	Acceptance rate					
	Strongly acceptable	Relatively acceptable	Neutral	Relatively opposed	Strongly opposed	Undetermined
Disease-or pest-resistant GM rice	26	42	20	6	1	5
Nutritionally improved GM rice	27	40	22	5	1	5
Pest-resistant GM fruit/vegetable	26	42	21	5	1	5
GM soybean oil	15	39	31	8	1	6
Livestock fed by GM maize	15	34	32	10	2	7
Average	22	39	25	7	1	6

Source: Authors' survey.

Among those consumers accepting GMFs, 22% recorded that GMFs were strongly acceptable and 39% described GMFs as relatively acceptable. If we exclude the consumers who are unclear about their attitude towards GMFs (7%), acceptance of GMFs reached 65% in 2002–2003 in urban China. Those strongly opposed to GMFs accounted for only 1% of our sample interviewees. It is also interesting to note that about one quarter of consumers were neutral to GMFs, which may indicate that their attitudes may change in the future as they receive more information on GMFs.

Similar to the findings in other countries, Chinese consumers' attitudes towards GMFs also differ among GMFs. Table 2 shows that consumer's acceptance rates were highest (67–78%) for the pest-resistant GM food crops (fruit, vegetable and rice) and the nutritionally improved GM rice, while only about half of consumers accepted the pork fed by GM maize. These are consistent with findings in other countries where GM livestock, even through there were just fed by GM feeds, often evoked relatively lower rates of acceptance (Hallman et al. 2002). An interesting phenomenon that needs further investment is that although the European consumers generally feel negative for GMFs, they seem to accept beef from Argentina and Brazil that was fed by with Bt corn and HT soybean.

Compared with many other countries, the acceptance of GMFs in China is rather high. For example, consumers' acceptance rate of 'nutritionally improved GM rice' was reported to be 51% in Japan and 46% in the UK (FAO 2004), which is about 20 percentage points lower than that in China. Because the consumers' neutral attitude to GMF can also be interpreted as no preference on non-GMF over GMF, analysts often grouped these consumers with those who accept GMF. If we account for this, Chinese consumers' acceptance rate of nutritionally improved GM rice reached as high as 89%, which is almost the highest value found in the literature. Even in the US, consumers' acceptance rate of GMF ranges from 50% (Hallman et al. 2003) to 59% (IFIC 2004).

Table 3. Consumers' trust in government's ability.

Characteristics	Consumers' trust in government ability (%)				
	Strongly trust	Trust	Neutral	Distrust	Strongly distrust
Individual characteristics					
Age					
<=39 years	9	32	38	18	3
40–59 years	13	42	34	8	2
>60 years	16	47	29	8	1
CCP membership					
0 year	12	37	36	11	3
1–20 years	12	45	33	9	1
>20 years	17	53	23	6	1
Occupation					
Government agencies	17	45	30	7	2
Retired	16	46	29	7	1
Enterprise	10	35	40	11	3
Others	8	36	38	14	3
Family characteristics					
With family member lay off					
Yes	9	33	40	16	3
No	14	44	32	8	2
Water cut off times per month					
0	14	44	32	8	2
0–1	12	30	40	15	3
>1	9	19	36	20	16
Monthly per capita income (yuan)					
<=500	9	31	43	14	4
500–1000	12	40	34	12	3
>1000	15	47	30	7	1
Residential cities					
Big city	16	43	32	7	2
Medium city	10	43	35	11	1
Small city	10	33	37	16	4
Total samples	12	40	35	11	2

Source: Authors' survey.

3.2. *Consumers' trust in government and their attitudes towards GMF*

In this study, consumers' trust in government is measured by their perception of government's ability to assist vulnerable people. Each respondent was asked to select one of the following five answers: great ability, moderate ability, little ability, lack of ability, and none. The 'great ability' is used as a proxy for 'strongly trust' in government and 'none' is a proxy for 'strongly distrust'. The survey results show that the majority of urban Chinese consumers trust in government: 12% of consumers strongly trusted in government and 40% of consumers trusted in government (see last row of Table 3). Consumers who felt distrust and strongly distrust government only accounted for 11% and 2%, respectively. The rest of the respondents (35%) were neutral.

Table 4. Consumers' acceptance of different GM foods by degree of consumers' trust in government (%).

	Acceptance rate[1] excluding samples with undetermined attitudes					
	Disease-or pest-resistant GM rice	Nutritionally improved GM rice	Pest-resistant GM fruit or vegetable	Oil from GM soybeans	Livestock fed by GM maize	Average acceptable rate (%)
Strongly trust	75	74	75	65	55	69
Relatively trust	68	68	70	55	49	62
Neutral	65	67	67	48	47	59
Relatively distrust	64	56	62	47	39	54
Strongly distrust	50	58	67	50	42	53

Note: [1]The acceptable includes both strongly and relatively acceptable. The samples distributions are 206 (strongly trust), 668 (relatively trust), 575 (neutral), 177 (relatively distrust), and 40 (strongly distrust).
Source: Authors' survey.

Consumers' trust in government appears to be associated with their demographic and other factors. Trust in government grows with respondents' age. Only 41% of consumers below 39 years old feel strong or relative trust in government, while the corresponding number for consumers older than 60 is 63% (1st column, Table 3). It is also expected that consumers who were members of Chinese Communist Party (CCP) trust more in government than those who were not, and the share of consumers' trust in government increased with years of CCP membership (4th–6th row, Table 3). Consumers working in government or public sectors and retired consumers have more trust in government than consumers working in other sectors. Not surprisingly, consumers with family members laid off have more distrust in government than those without. An interesting finding is that consumers' distrust in government consistently increased with the number of times water being cut-off happened in their family during the year. In our survey, we also asked about the frequency of electric power being cut-off, but found only a very slight correlation between this and consumers' trust in government. A possible explanation for this is that, in urban areas, the inconvenience caused by water cut-off is higher than electric power cut-off. Another implication of this finding is that consumers' trust in government can be affected not only by the food industry policy but also by management performance in other public areas, such as even the building of the water supply infrastructure, which seems far from the food industry. Consumers' trust in government also increased with their income and the size of their residential cities (Table 3).

Table 4 provides evidence of a positive relationship between consumers' attitudes towards GMF and their trust in government. For all five GMFs examined in this study, consumers' acceptance rates consistently increased with the rise of their trust in government (Table 4). On the average, the acceptance rate for consumers who

strongly trust in government was 69%, while the corresponding number for consumers who strongly distrust government was only 53% (last column, Table 4).

The positive relationship between consumers' trust in government and their acceptance of GMF is also confirmed by other questions asked during our survey. For example, when we asked the following question, 'if GMFs' safety has been tested by government before they were authorized for commercialization, can this increase your confidence to GMFs?', more than 80% of interviewees answered this question 'sure' or 'yes'.

4. Models and estimation results

4.1. *Model specification*

To examine the effects of consumers' trust in government on their attitudes towards GMF, we have to control other factors that also simultaneously affect consumers' attitudes. A general model of consumers' acceptance of GMF is specified as follows:

$$A_{it} = f_1(B_{it}, I_{it}, T_{it}, R_{it}, H_{it}, v_{1it}) \tag{1}$$

where, the dependent variable, A_{it}, is the ith consumer's acceptance of GMFs in year t. The explanatory variable, B_{it}, is the consumers' trust in government. I is a dummy variable for the respondents who were re-interviewed in 2003 (with a value of 1 in 2003 for those interviewed in 2002 and re-interviewed in 2003 and zero otherwise). We include this dummy variable for the re-interviewed respondents because we are also interested in testing whether or not these respondents changed their attitudes more than others after they received our interviews in 2002. Because our survey and information asked during interviews are neutral, we expect that these re-interviewed respondents have more knowledge about GMF in 2003 than that in 2002. T_{it} is the time dummy variable with 1 for year 2003 and 0 for year 2002. Including a year dummy in the model tests whether or not there was any change in consumers' attitudes towards GMF due to some factors that changed in 2003 over 2002 but were excluded in the model. R_{it} is a vector of respondent's individual characteristics, including gender (male=1), age, education, and occupation. H_{it} represents respondent's household or family characteristics, including per capita monthly income and three dummy variables for the size of the residential city (big, medium or small size cities), a family with a child under ten years old, and any family member(s) who ever experienced food allergies in the past.

In this article, we take an ordered Probit form for model (1). The dependent variable A_{it} has five discrete levels: strongly accept, relatively accept, neutral, relatively opposed, and strongly opposed. In the regression, we excluded those respondents with unclear or undetermined decision on their acceptance of GMF, which is about 6% of total interviewees (ranging from 5% to 7% for different GMFs, see last column of Table 2). Because the number of respondents with an undetermined decision varies among various GMFs, the effective samples used in regressions also differ slightly among GMFs. In the regressions we converted 'trust in government' to a binary variable, although it has five levels in our survey, because otherwise we will not have enough instrumental variables when we deal with the endogeneity problem of 'trust in government'. Consumers who strongly trust in

government or relatively trust in government take the value 1, and other consumers take the value 0. To test the robustness of the regression results, we also reported the linear regression results of model (1) in Appendix Table A1, where we assume consumers' acceptance to GM foods and their trust in government are both continuous variables. Our results showed that the ordered Probit and linear regression results are very consistent in terms of the signs and significances of the dependant variables.

Direct estimation of the impacts of consumers' trust in government on their attitudes towards GMFs based on equation (1) will be biased as there are reasons to believe that consumers' trust in government is endogenous to the model specified above. As mentioned earlier, since some factors that are not included in the model can simultaneously affect consumers' trust in government and their attitudes towards GMF, omitting these variables will lead to the endogenous problem of trust in government in equation (1). To deal with these endogeneity problems, we need appropriate instrumental variables that can effectively explain the variations of consumers' trust in government. In this study, the following auxiliary model is specified:

$$B_{it} = f_2(IV_{it}, I_{it}, T_{it}, R_{it}, H_{it}, v_{2it}) \tag{2}$$

where B_{it} is a binary (zero or one) variable as we explained above. The *IV*s are instrumental variables that include the following three variables: the years of membership in the Chinese Community Party, households with laid-off family member(s) in the past three years (a dummy variable with 1 if there was and zero otherwise), and frequency of water cut-off (measured as times per month in his/her home). We consider these three variables as potential *IV*s because they are not expected to directly impact on consumers' attitudes towards GMF except through their impacts on consumers' trust in government. Whether or not they are good instrumental variables for consumers' trust in government will be tested empirically and discussed in the next section. A probit model is used to estimate this equation.In the analysis, we first estimated equation (2) with Probit, then substitute 'trust in government' in the ordered Probit estimation of equation (1) with the predicted value of B_{it} from the Probit regression of equation (2). We also examined the endogeneity of consumers' trust in government in equation (2) by testing whether the error terms of equations (1) and (2) are significantly correlated. If they are correlated, that means consumers' trust in government is endogenous (Wooldridge 2002). The results showed that consumers' trust in government has a significant endogenity problem for four of the five studied foods (*rho*, at the last second row of Tables 6 and 7). Even though for 'GM soybean oil', the only food for which *rho* is not significant, the *t*-value is 1.42, which is almost significant at the 10% level.

To test the robustness of the estimation results considering the endogeneity of 'trust in government', we also did 2SLS linear regressions on equations (1) and (2) simultaneously, where we assume consumers' acceptance to GM foods and their trust in government are continuous variables. The estimation results of equation (1) are reported in Appendix Table A2. Basmann's over-identification test in this linear regression shows that all the three instrumental variables are valid (Appendix Table A2). The Durbin-Wu-Hausman test is also conducted to test the endogeneity of

'trust in government', and the results show that, consistently with the endogeneity test in the two-stage discrete dependent variable regressions, 'trust in government' has a significant endogenity problem except for 'oil from GM soybean'. The ordered Probit and linear estimation results of equation (1) with consideration of the endogeneity problem are highly consistent, so in the following discussions we only focus on the results of the ordered Probit regressions.

4.2. *Results*

The results of econometric estimations of equations (1), without considering the endogeneity of 'trust in government' are presented in Table 5, and estimation results for the consumers' acceptance to different GMFs considering endogeneity problems are presented in Tables 6 and 7. Table 6 shows the regression results for disease or pest-resistant GM rice and nutritionally improved GM rice. Table 7 presents the results for pest-resistant GM fruit/vegetable, GM soybean oil, and pork fed by GM maize.

The estimated parameters of consumers' trust in government and consumer's acceptance towards GMF equations have the expected positive sign and are statistically significant in all five GMFs studied (1st row of Table 5, and 4th row of Tables 6 and 7). The significant and positive signs of estimated parameters of consumers' trust show that consumers' acceptance of GMF will rise with the improvement of consumers' trust in government. This result emphasizes the important role of government in shaping consumers' attitudes towards GMF.

Estimation results in Table 6 and 7 also show that the parameters for all three instrumental variables in the equation of consumers' trust in government have expected signs and are statistically significant in 1% or 5% levels for each of the five GMFs (Tables 6 and 7). The longer the respondent has been a member of the Chinese Community Party the more he/she trusts in the government (1st row, Tables 6 and 7), which is what we should expect. For the respondents with family member(s) laid off in the last three years, their trust in government is significantly lower than the others with no laid off workers in their families (2nd row). The consumers' trust in government also declines with increasing frequency of water supply cut-off in their families (3rd row). The parameters for other factors in consumers' trust in government, such as age, income and residential location, also have expected signs (Tables 6 and 7). For example, old people feel more trust in government, and people who worked in government agencies or who are retired have more trust in government. As expected, the consumers with higher income feel more trust in government. Compared with consumers living in big cities, consumers in small cities have significantly less trust in government.

It is interesting to note that information and knowledge about GMF may positively contribute to consumers' acceptance of GMF. For example, in the consumers' acceptance of GMF equations, the estimated parameters for the respondents who are re-interviewed in 2003 are all positive and significant in four of five GMFs studied (2nd row in Table 5, and 5th row in Tables 6 and 7). The positive sign of these parameters may indicate that information and knowledge about GMF are also important factors in determining consumers' acceptance

Table 5. Estimation results of consumers' acceptance to GM foods using ordered Probit models.

	Disease- or pest-resistant GM rice	Nutritionally improved GM rice	Pest-resistant GM fruit/ vegetable	Oil from GM soybeans	Pork fed by GM maize
Trust in government	0.112	0.115	0.092	0.193	0.124
	(2.06)**	(2.11)**	(1.69)*	(3.58)***	(2.31)**
Re-interviewed in 2003	0.344	0.105	0.314	0.223	0.141
	(4.65)***	(1.44)	(4.23)***	(3.06)***	(1.97)**
2003 year dummy	0.008	0.030	0.030	0.081	0.076
	(0.11)	(0.41)	(0.40)	(1.12)	(1.05)
Respondent's characteristics:					
Gender (male=1)	0.126	0.063	0.097	0.100	0.039
	(2.27)**	(1.14)	(1.75)*	(1.83)*	(0.72)
Age (year)	−0.001	0.002	−0.002	0.004	0.003
	(−0.41)	(0.86)	(−0.91)	(0.77)	(1.37)
Education (year)	0.007	0.011	0.003	0.004	0.008
	(0.68)	(1.09)	(0.26)	(0.37)	(0.77)
Worked in government agencies	0.164	0.163	0.152	0.173	0.146
	(2.39)**	(2.37)**	(2.21)**	(2.55)**	(2.15)**
Retired	0.096	0.048	0.033	0.031	−0.052
	(1.01)	(0.50)	(0.34)	(0.33)	(0.55)
Household's characteristics:					
Monthly per capita income	−0.142	−0.115	−0.109	−0.135	−0.124
	(−3.07)***	(−2.47)**	(−2.36)**	(−2.96)***	(−2.70)***
Resident in medium cities	0.139	0.094	0.021	0.140	0.051
	(2.13)**	(1.44)	(0.33)	(2.16)**	(0.79)
Resident in small cities	0.188	0.240	0.174	0.202	0.292
	(2.78)***	(3.53)***	(2.56)***	(3.01)***	(4.36)***
Family experienced food allergy	0.030	0.008	0.119	0.066	−0.106
	(0.35)	(0.09)	(1.40)	(0.45)	(−1.29)
With children under 10 years old	−0.006	0.014	0.011	−0.077	−0.009
	(−0.08)	(0.20)	(0.15)	(−1.10)	(−0.13)
Constants	–	–	–	–	–
Pseudo R-square	0.013	0.008	0.011	0.015	0.011
Samples	1586	1587	1589	1570	1544

Note: * significant at 10%, ** significant at 5%, and *** significant at 1%. There are four constant terms in this ordered Probit regression. We did not report the estimated parameters for these constant terms here.

of GMF.[6] Providing more and balanced information to the public may increase consumers' acceptance of GMF.

Other major factors affecting consumers' attitudes towards GMF include income and the residential location (size of city). Increasing income has significant negative impacts on consumers' acceptance of GMF. This result is consistent with previous findings in many other studies (Pinstrup-Andersen and Cohen 2001; Lin et al. 2006). Our study also finds that, compared with consumers in big cities, consumers in medium and small cities tend to have a higher acceptance of GMFs.

Table 6. Estimation results of consumers' trust in government and their acceptance of GM rice using discrete independent models (Probit and Ordered Probit).

	Disease-or pest-resistant GM rice		Nutritionally improved GM rice	
	Trust in government	Acceptance	Trust in government	Acceptance
Years being CCP member	0.008		0.008	
	(2.58)***		(2.58)***	
With laid-off family member	−0.161		−0.179	
	(−2.27)**		(−2.51)**	
Water cut-off per month	−0.252		−0.260	
	(−2.34)**		(−2.41)**	
Trust in government		0.160		0.771
		(2.47)**		(1.75)*
Re-interviewed in 2003	−0.131	0.297	−0.136	0.115
	(−1.44)	(3.90)***	(−1.49)	(1.53)
2003 year dummy	0.043	0.008	0.039	0.020
	(0.47)	(0.10)	(0.43)	(0.26)
Respondent's characteristics:				
Gender (male = 1)	−0.107	0.118	−0.114	0.066
	(−1.56)	(1.99)**	(−1.67)*	(1.10)
Age (year)	0.014	−0.001	0.014	−0.002
	(4.36)***	(−0.23)	(4.31)***	(−0.41)
Education (year)	0.004	0.003	0.004	0.007
	(0.29)	(0.29)	(0.29)	(0.64)
Worked in government agencies	0.294	0.139	0.282	0.073
	(3.54)***	(1.50)	(3.4)***	(0.81)
Retired	0.266	0.074	0.255	−0.028
	(2.31)**	(0.67)	(2.20)**	(−0.26)
Household's characteristics:				
Monthly per capita income	0.137	−0.151	0.135	−0.170
	(2.37)**	(−2.67)***	(2.35)**	(−3.03)***
Resident in medium cities	−0.014	0.125	−0.005	0.082
	(−0.18)	(1.85)*	(−0.06)	(1.22)
Resident in small cities	−0.185	0.212	−0.176	0.314
	(−2.22)**	(2.60)***	(−2.11)**	(3.90)***
Family experienced food allergy	0.068	0.028	0.051	−0.007
	(0.67)	(0.32)	(0.50)	(−0.09)
With children under 10 years old	−0.016	−0.005	0.010	0.006
	(−0.18)	(−0.07)	(0.12)	(0.08)
Constants	−0.681	–	−0.666	
	(−2.82)***		(−2.75)***	
rho	(−1.76)*		(−1.99)**	
Samples	1586		1587	

Note: * significant at 10%, ** significant at 5%, and *** significant at 1%. *rho* is the correlation parameter for the two error terms of equation 1 and 2, which is used for the endogenous test of 'trust in government' (Wooldridge 2002). The significance of rho means a endogenous variable of 'trust on government'.

Table 7. Estimation results of consumers' trust in government and their acceptance of other GM foods using discrete independent models (Probit and Ordered Probit).

	Pest-resistant GM fruit/vegetable		Oil from GM soybeans		Pork fed by GM maize	
	Trust in government	Acceptance	Trust in government	Acceptance	Trust in government	Acceptance
Years being CCP member	0.007		0.007		0.008	
	(2.50)**		(2.44)**		(2.70)***	
With laid-off family member	−0.146		−0.166		−0.154	
	(−2.04)**		(−2.32)**		(−2.13)**	
Water cut-off per month	−0.250		−0.252		−0.249	
	(−2.33)**		(−2.35)**		(−2.33)**	
Trust in government		1.435		0.903		1.100
		(2.56)***		(1.74)*		(2.15)**
Re-interviewed in 2003	−0.119	0.062	−0.124	0.098	−0.122	0.157
	(−1.32)	(3.41)***	(−1.36)	(2.80)***	(−1.33)	(2.09)**
2003 year dummy	0.022	0.259	0.025	0.211	0.025	0.051
	(0.24)	(0.82)	(0.27)	(1.31)	(0.27)	(0.67)
Respondent's characteristics:						
Gender (male=1)	−0.110	0.131	−0.110	0.110	−0.129	0.071
	(−1.61)	(2.18)**	(−1.60)	(1.85)*	(−1.86)*	(1.18)
Age (year)						

	0.015	−0.012	0.015	−0.001	0.015	−0.003
	(4.64)***	(−0.52)	(4.51)***	(−0.23)	(4.44)***	(−0.75)
Education (year)	0.004	−0.005	0.004	−0.003	0.008	0.001
	(0.37)	(−0.49)	(0.36)	(−0.30)	(0.62)	(0.14)
Worked in government agencies	0.295	−0.022	0.292	0.047	0.282	0.023
	(3.56)***	(−0.23)	(3.51)***	(0.51)	(3.36)***	(0.26)
Retired	0.283	−0.143	0.254	−0.051	0.283	−0.164
	(2.46)**	(−1.27)	(2.19)**	(−0.48)	(2.41)**	(−1.48)
Household's characteristics:						
Monthly per	0.134	−0.198	0.128	−0.191	0.128	−0.187
capita income	(2.33)***	(−3.46)***	(2.22)**	(−3.44)***	(2.20)**	(−3.37)***
Resident in medium cities	−0.018	0.019	−0.014	0.134	0.012	0.046
	(−0.22)	(0.28)	(−0.18)	(2.00)**	(0.15)	(0.69)
Resident in small cities	−0.192	0.294	−0.169	0.324	−0.154	0.373
	(−2.31)**	(3.52)***	(−2.01)**	(4.07)***	(−1.82)*	(4.76)***
Family experienced food allergy	0.037	0.082	0.071	−0.036	0.081	−0.139
	(0.37)	(0.95)	(0.70)	(−0.42)	(0.78)	(−1.59)
With children under 10 years old	0.014	0.007	0.007	−0.095	0.010	−0.007
	(0.16)	(0.10)	(0.08)	(−1.30)	(0.01)	(−0.09)
Constants	−0.732	–	−0.702	–	−0.747	–
	(−3.01)***		(−2.87)***		(−3.04)***	
rho	(−2.54)**		(−1.42)		(−1.71)*	
Samples	1589		1570		1544	

Note: * significant at 10%, ** significant at 5%, and *** significant at 1%. *rho* is the correlation parameter for the two error terms of equation 1 and 2, which is used for the endogenous test of 'trust in government' (Wooldridge 2002). The significance of *rho* means a endogenous variable of 'trust on government'.

Other factors, such as age and education, generally have insignificant impacts on consumers' attitudes towards GMF. The impact of gender is different across GM foods. For example, men are more positive towards pest-resistant GM rice, pest-resistant fruit/vegetable, and GM soybean oil, but this variable plays little role in acceptance of the nutritionally improved GM rice and pork fed by GM maize.

An obvious difference between the estimation results of considering and not considering the endogenous problem of 'trust in government' is the impact of 'worked in government agencies'. If we do not consider the endogeneity problem, consumers who worked in government agencies have a significantly higher acceptance to GMFs, as shown in Table 5. However, when we consider the endogeneity problem of 'trust in government', this variable generally has no significant impact on consumers' acceptance to GMFs (Tables 6 and 7). An explanation for this difference is that 'worked in government agencies' only has an indirect impact (through 'trust in government') to consumers' acceptance to GMFs. When we consider the endogeneity problem of 'trust in government', and do two-stage regressions, the indirect impact of 'worked in government agencies' was absorbed by 'trust in government' as shown in the estimation results of equation (2), and the results of the second stage regression showed that 'worked in government agencies' has no direct impact to consumers' acceptance to GMFs.

Our study also shows that ignoring the endogeneity of consumers' trust in government will lead to underestimation of its impacts on consumers' acceptance of GMF. The comparison of the parameters of 'trust in government' in Table 5 (where we did not consider the endogeneity problem) with its parameters in Tables 6 and 7 (where we considered the endogeneity problem) shows that the parameters of consumers' trust in government are much smaller in the models that do not consider endogeneity. For example, the parameter of trust in government for the pest-resistant fruit/vegetable is only 0.092 if we do not consider endogeneity, while the corresponding parameter increased to 1.435 after we handled endogeneity. The variation of this coefficient for the other four GMFs follows the same pattern, although the magnitude of these variations was not exactly the same. This implies that previous studies (Moon and Balasubramanian 2001; Curtis et al. 2004; Hossain and Onyango 2004) may underestimate the impact of consumers' trust in government on their acceptance of GMF.

5. Concluding remarks

This study examines Chinese consumers' trust in government and their acceptance of GMF. Our results show that more than half of urban Chinese consumers feel trust in government's public management abilities. Only 13% of consumers in this study feel relative or strong distrust in government. The consumers' acceptance of GMF in urban China also is high. The number of consumers who clearly indicated opposition to GMF is small, accounting for only about 6–12%. Similar to many studies in other countries, consumers express a greater acceptance of GM food crops than GM meats even though the livestock is only fed by GM feed. Many consumers, about 25 to 40%, are either neutral towards or undetermined in their attitudes towards GMF.

This suggests that the trends of key determinants of consumers' attitudes towards GMF will shape China's market for GMF in the future.

Among many factors, consumers' trust in government is found to have a significantly positive impact on their acceptance of GMF, which has important implications for any government that wants to pursue the development of GMF. This is, to the best of our knowledge, the first empirical study of the impact of consumers' trust in government on their attitudes towards GMF that considers the endogeneity of this variable. Moreover, we show that failure to consider the endogeneity of consumers' trust in government will lead to underestimation of its impact on consumers' acceptance of GMF.

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Notes

1. There are complex discussions on the differences between definitions of trust and confidence. Seminal discussions can be find in Luhmann (1988) and Siegrist, Earle, and Gutscher (2003), Here we use the term of 'trust' following most studies in this area.
2. The two big cities are Beijing and Shanghai; three medium size cities are Nanjing of Jiangsu province, Jinan of Shangdong province, and Ningbo of Zhejiang province; six small cities are Dezhou and Weihai in Shangdong province, Yancheng and Nantong in Jiansu province, and Shaoxing and Jinghua in Zhejiang province.
3. We intended to have an effective sample of 1000 respondents in 2002 and selected 1020 for interviews. Eventually, we interviewed 1005 individuals. The other 15 individuals were not interviewed either because they were not at home (nine) or turned down our interviews (six).
4. Major instrument variables are: how long has the respondent been a member of the Chinese Communist Party, whether or not there is any member in the respondent's family who has been laid off, and how many times has water cut-off happened in the family in these years. Since those are all objective questions, the answers will not change regardless of whether the questions were asked in 2002 or 2003.
5. In 2003, all 666 respondents who interviewed in 2002 received our interviews. An additional 340 randomly selected samples were added in 2003, among them 334 received our interviews, two were not at home and the other four turned down the interviews request.
6. Note again that all interviewers provided no favourable or unfavourable information about GMF during the surveys, and were trained to be neutral during the survey.

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Appendix

Table A1. Estimation results of consumers' acceptance to GM foods using linear regression models.

	Disease- or pest-resistant GM rice	Nutritionally improved GM rice	Pest-resistant GM fruit/ vegetable	Oil from GM soybeans	Pork fed by GM maize
Trust in government	0.086	0.078	0.075	0.114	0.079
	(3.52)***	(3.29)***	(3.16)***	(4.44)***	(3.11)***
Re-interviewed in 2003	0.014	0.085	0.028	0.074	0.123
	(4.67)***	(1.45)	(4.33)***	(3.09)***	(1.97)**
2003 year dummy	0.284	0.024	0.255	0.198	0.068
	(0.24)	(0.40)	(0.49)	(1.16)	(1.07)
Respondent's characteristics:					
Gender (male=1)	0.108	0.052	0.083	0.094	0.035
	(2.37)**	(1.17)	(1.88)*	(1.96)**	(0.74)
Age (year)	−0.002	0.001	−0.002	0.003	0.003
	(−0.79)	(0.62)	(−0.85)	(0.52)	(1.19)
Education (year)	0.005	0.009	0.001	0.002	0.007
	(0.60)	(1.09)	(0.10)	(0.27)	(0.77)
Worked in government agencies	0.124	0.125	0.113	0.141	0.118
	(2.20)**	(2.25)**	(2.07)**	(2.38)**	(2.00)**
Retired	0.080	0.045	0.035	0.033	−0.042
	(1.02)	(0.59)	(0.46)	(0.40)	(−0.51)
Household's characteristics:					
Monthly per capita income	−0.123	−0.099	−0.092	−0.119	−0.111
	(−3.21)***	(−2.64)***	(−2.49)**	(−2.95)***	(−2.78)***
Resident in medium cities	0.125	0.082	0.026	0.127	0.050
	(2.32)**	(1.56)	(0.50)	(2.24)**	(0.89)
Resident in small cities	0.175	0.207	0.153	0.187	0.265
	(3.13)***	(3.78)***	(2.83)***	(3.17)***	(4.54)***
Family experienced food allergy	0.027	0.009	0.088	0.010	−0.090
	(0.39)	(0.13)	(1.30)	(0.13)	(−1.25)
With children under 10 years old	−0.005	0.015	0.012	−0.060	−0.006
	(−0.09)	(0.26)	(0.22)	(−0.97)	(−0.10)
Constants	3.342	3.360	3.528	2.763	2.916
	(3.45)***	(4.30)***	(3.98)***	(3.21)***	(3.49)***
R-square	0.040	0.026	0.033	0.042	0.034
Samples	1586	1587	1589	1570	1544

Note: * significant at 10%, ** significant at 5%, and *** significant at 1%.

Table A2. Estimation results of consumers' trust in government and their acceptance of GM foods using continuous independent models.

	Disease-or pest-resistant GM rice	Nutritionally improved GM rice	Pest-resistant GM fruit/ vegetable	Oil from GM soybeans	Pork fed by GM maize
Trust in government	0.158	0.483	0.817	0.476	0.828
	(1.68)*	(1.84)*	(2.44)**	(1.74)*	(2.40)**
Re-interviewed in 2003	0.008	0.095	0.054	0.078	0.146
	(3.89)***	(1.46)	(2.88)***	(2.73)***	(1.77)*
2003 year dummy	0.245	−0.016	0.221	0.183	0.059
	(0.12)	(−0.24)	(0.71)	(1.19)	(0.70)
Respondent's characteristics:					
Gender (male=1)	0.107	0.066	0.124	0.101	0.091
	(2.13)**	(1.24)	(2.00)**	(1.87)*	(1.33)
Age (year)	−0.002	−0.004	−0.013	−0.002	−0.007
	(−0.62)	(−0.89)	(−1.39)	(−0.51)	(−1.34)
Education (year)	0.001	0.006	−0.004	−0.001	0.003
	(0.18)	(0.66)	(−0.39)	(−0.15)	(0.30)
Worked in government agencies	0.091	0.015	−0.081	0.004	−0.066
	(1.08)	(0.18)	(−0.75)	(0.05)	(−0.59)
Retired	0.057	−0.002	−0.066	−0.012	−0.123
	(0.67)	(−0.02)	(−0.64)	(−0.14)	(−1.10)
Household's characteristics:					
Monthly per capita income	−0.138	−0.158	−0.180	−0.165	−0.206
	(−2.83)***	(−3.13)***	(−3.01)***	(−3.26)***	(−3.21)***
Resident in medium cities	0.120	0.093	0.058	0.129	0.089
	(2.04)**	(1.51)	(0.80)	(2.09)**	(1.15)
Resident in small cities	0.212	0.316	0.330	0.316	0.452
	(2.61)***	(3.77)***	(3.19)***	(3.73)***	(4.20)***
Family experienced food allergy	0.025	0.011	0.083	−0.006	−0.097
	(0.35)	(0.15)	(0.96)	(−0.08)	(−1.02)
With children under 10 years old	−0.002	0.023	0.033	−0.066	0.007
	(−0.03)	(0.35)	(0.44)	(−1.02)	(0.08)
Constants	3.246	2.316	1.565	1.917	0.876
	(4.39)***	(3.05)***	(1.63)	(2.43)**	(0.88)
Basmann test (*P*-value)	0.392	0.586	0.452	0.774	0.292
Durbin-Wu-Hausman test (*P*-value)	0.065*	0.007***	0.004***	0.122	0.037**
Samples	1586	1587	1589	1570	1544

Note: * significant at 10%, ** significant at 5%, and *** significant at 1%.
Basmann over identification test was used for the test the validity of the instrumental variables (Basmann 1960). The null hypothesis is that the excluded instruments are valid instruments, i.e. uncorrelated with the error term.
Durbin-Wu-Hausman test was used for test the endogeneity of 'trust in government'. The null hypothesis is that this variable is exogenous (Wooldridge 2002).