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Do Consumers Really Care About Genetically Modified (GM) Food Label? What Do We Know? What Else Should We Know?

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ABSTRACT

This paper employs household survey data to examine whether GM food labeling has an impact on consumers' vegetable oil purchasing decision. Direct variables indicating consumers' response to label regulation are employed to test labeling effect. We find that supermarket customers who concern GM label or GM material have respectively 4.1-7.5 percent and 9.8-12.3 percent lower probability of buying GM oil. Meanwhile, their probability of switching from GM oil to non-GM oil after labeling enforcement is higher by 10.5 percent and 12.7 percent respectively. The empirical results support our previous finding that in the short run the market share of GM oil decreased significantly by a small amount as a result of label enforcement.

JEL Classification: Q13, Q17, Q18.
Keywords: GM food labeling, household survey data, aggregate market share, China.

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1 INTRODUCTION AND LITERATURE

Recently, there have been fierce debates among different countries, environmental protection agencies, consumers groups and scholars regarding whether GM food labeling is necessary and what kind of labeling policy should be adopted. Some countries or economies, such as the European Union, Japan and China, have implemented mandatory labeling policy. Other countries, such as the U.S. and Canada, have adopted voluntary labeling policy that leaves the decision whether to label GM food to each enterprise.

The mandatory labeling of GM food aims to provide consumer choice. Even among those countries that have adopted mandatory labeling policy, the market performances are very much differentiated. In the European Union, GM food with mandatory labeling has disappeared from the retail shelves. Additional evidence in Japan shows that it is difficult (if not impossible) to find retail food products labeled as containing GM ingredients. Mandatory labeling also exists in Australia and New Zealand, where there is no much choice at the retail level (Carter, C.A. et al., 2003).

Unlike the above-mentioned countries, markets for some GM products are developing rapidly. China has established a mandatory labeling regulation since March 2002 which stipulates that all products containing GM ingredients should be labeled, including seeds, animal feed and food products. The GM labeling policy has been successfully enforced in the vegetable oil industry after August 2003 under the strict supervision of central and local governments. Nowadays, market share of GM oil (mainly GM soybean oil) still maintains a dominant level in urban China, except in the northeast region and the North China Plain where there is vast arable land growing non-GM soybean (see areas in dark green color in Figure 1). Overall, soybean oil accounts for a dominant share of vegetable oil consumption in urban China, while peanut oil, sun flower seed oil and other types of vegetable oils take up a minor share (Zhong et al., 2006).

In the last two decades in China, growth in GM soybean oil consumption has been compensated by fast growth in net imports, while domestic production has been stagnated (USDA, 2007). Meanwhile, by 2005 China has become the world's largest soybean importer (USDA, 2006). Therefore, the recent labeling regulation of China is expected to have a significant impact on international trading

partners of GM products, such as herbicide-tolerant soybeans from the U.S. (Marchant et al., 2003), Argentina and Brazil (USDA, 2007). However, the degree of impact should ultimately be determined by consumers' acceptance of GM food and its labeling as well as the effect that the labeling has on consumers' attitudes and behaviors, particularly in the long run. Today, GM foods have entered the daily diet of Chinese consumers. Survey-based studies in China repeatedly show that consumers overwhelmingly favor mandatory GM labeling. However, Zhong et al. (2004) believe that labeling cannot actually change consumers' attitudes toward GM foods if it is merely a mechanism to differentiate GM from non-GM foods. 1999 and 2002 AFIC surveys even find that consumers do not check food labels for information on biotechnology. [4]

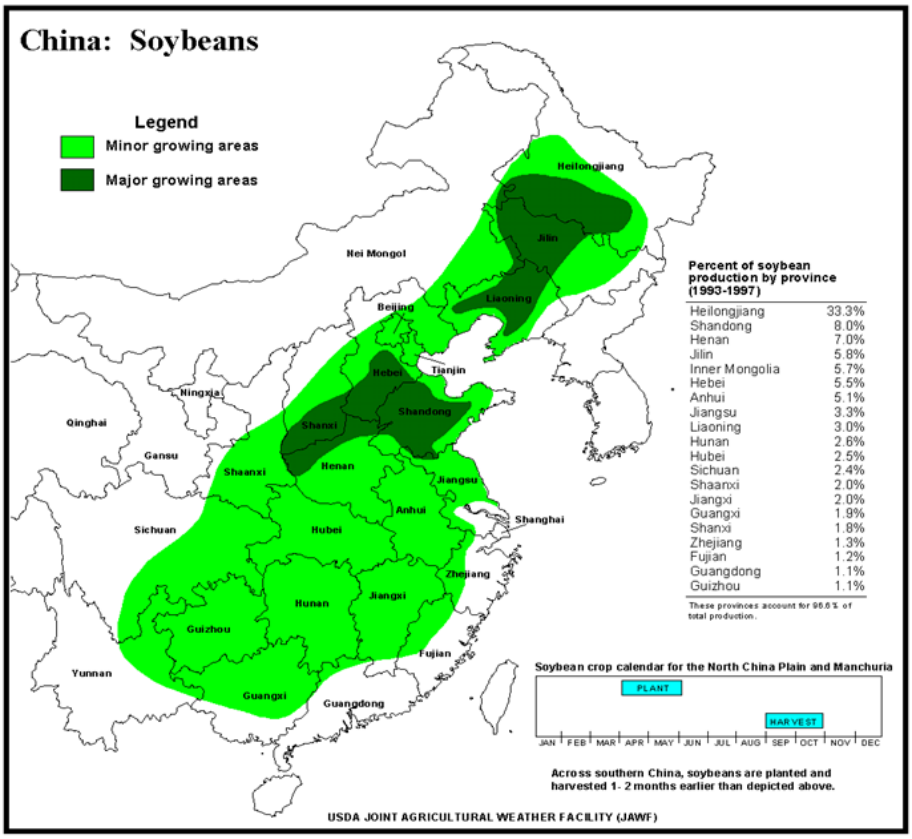
As we know, the information provided on the label is neutral aimed at informing consumers the product they see contains GM ingredients. Hence, it provides a good chance to explore the impact of mandatory GM food labeling policy. However, virtually all previous studies of consumer attitudes toward GM foods, labeling, and willingness to pay (WTP) in China and other countries (Zhong et al., 2002; Zhong et al., 2004; Bai, 2003; AFIC, 2004; IFIC, 2004; Chen et al., 2004; Li et al., 2003; Ding, 2004; Hou et al., 2004; Lin et al., 2006a) are based on surveys of consumers' stated preferences, which may be subject to several serious problems (Zhong et al., 2006). As a result, while these studies have provided valuable information about consumer behaviors toward GM foods, the actual behavior of consumers on GM foods and the impact of GM label on consumers' behavior still remain unknown.

Since then, researches into consumers' revealed preferences are preferable. Zhong et al. (2006) employs supermarket retail sales data to show that the market share of GM oils significantly decreased 4 percent as a result of GM label enforcement. Besides that, in the long run, GM oil would sustain a dominative market share, though small and statistically insignificant in its growing trend. Lin et al. (2006c) find a similar result that the market share of GM oil decreased 2 percent after labeling enforcement. The two studies differentiate with

[4] 98% of Chinese respondents checked food labels regularly. Most common label items checked were expiry date, ingredients and nutritional value. Only 2% of Chinese survey respondents checked for presence of GM ingredients. When asked what additional information they would like to see on food labels, presence of GM ingredients was not mentioned by any of the respondents.

each other in three aspects; first, Zhong et al. use partial equilibrium model with one econometric equation, while Lin et al. apply a demand system named AIDS; second, Zhong et al. apply sales volume to measure market share, while Lin et al. use sales value. The results would be different with the change of relative price between GM oil and non-GM oil; third, Zhong et al. assume that labeling effect would be released in a few months, much longer than Lin et al.

Figure 1 Major Non-GM Soybean Growing Regions in China



Source: USDA Joint Agricultural Weather Facility (JAWF). http://www.usda.gov/oce/weather/

Note: Soybean oil is the main type of vegetable oil in the diet of Chinese urban residents. Soybean imported from the world market is mainly GM type, which accounts for the source of GM oil production material in the Chinese vegetable oil industry. The two regions in China marked in dark green are major growing areas for non-GM soybean, in which some market share of vegetable oil has been taken up by local non-GM soybean, while in most of the other regions the market share of GM oil is dominant.

To further explain individuals' behavior and the trend of resulting aggregate market share, Zhong et al. (2009) employ an urban household survey data[5] to calculate the number and ratio of consumers who follow the structural effect[6] and gross consumption effect[7] and their influences on the market share of GM oil. Results show that the changes of GM oil market share are affected by the structural effect of the rich, while there is no apparent gross consumption effect of the poor. Because of the similar data length, starting point, and ending point compared to retail sales data, the estimate of market share of GM oil using household survey data further proves the significantly downward trend of GM oil in the short run after the enforcement of labeling policy.

However, Zhong et al. (2009) does not adopt from the household survey data a variable directly capturing the effect of labeling effect, which actually leaves the discussion of labeling effect open. Meanwhile, an evaluation based on labeling effect indicators serves as the key to credibly link the aggregate retail sales data and micro household survey data. Accordingly, a central question to be addressed in this paper is: based on household survey data, is there any direct evidence supporting the role played by GM food labeling? Further, after a series of researches on this issue, it is right time to consider the need for the future study.

This paper is organized as follows: section 1 presents the labeling policy debate around the world and what we have learned from previous studies; section 2 presents variables, model, and data; section 3 presents empirical analysis using household survey data and deals with the issue of endogeneity; section 4 briefly concludes with a discussion on policy implications; section 5 presents what else we

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[5] Confining their research focus on consumers who purchase vegetable oil in supermarkets in consistency with previous actual sales data, Zhong et al. are able to explain what makes people choose GM oil in supermarket.

[6] As Income increases for most consumers in recent years, more and more people start buying vegetable oil in supermarket, and GM oils of lower price are their best choices. This continuing trend, namely gross consumption effect, would drive up the market share of GM oil.

[7] Consumers in supermarket transfer from buying GM oil to non-GM oil as income increases further. This ongoing trend, namely structural effect, would definitely reduce the market share of GM oil.

should know about consumers' preferences and actual purchasing decision, GM food labeling, and the market trend in the long run.

2 METHODS AND DATA

The remaining questions are all from individual consumers' perspective, including whether GM food labeling induces a switch in consumers' purchasing decision away from GM oil, whether it will last long, and what are the major influencing factors behind the market trend? To address these issues, the following empirical tests are employed to push forward the research of this field. The binary Probit model is specified as follows:

$$(2.1)\quad \Pr(Y_1=1)=\Phi(\alpha+\beta_1 Buyer+\beta_2 Risk+\beta_3 Hou)$$

$$(2.2)\quad \Pr(Y_2=1)=\Phi(\alpha+\gamma_1 Buyer+\gamma_2 Risk+\gamma_3 Hou)$$

The coding is as follows: Y_1=1 if the respondent currently purchases GM oil, 0 otherwise; Y_2=1 if the respondent switches from buying GM oil to non-GM oil in supermarket, 0 otherwise.[8] Factors that influence consumers' purchasing decisions are classified into four categories: buyer's demographic characteristics including gender, age and education; risk consciousness including child, food allergy, concern over GM food label and concern over GM material; household socioeconomic factors comprising monthly income per capita and city size.

Concern over GM label that is embodied in the dummy variable "whether to look at GM label when making purchasing decisions" may raise the problem of endogeneity. That is, Concern over GM label in the purchasing preference equation becomes interdependent with the error term, which gives rise to biased estimates (Maddala, 1997). The above ordinary Probit model is extended to include the use of an instrumental variable method. Media access including internet, TV, radio, newspaper, and magazine are employed as an instrumental

[8] Some consumers may diversify their purchasing decisions between GM oils and non-GM oils, but it is reasonable to believe that GM oils or non-GM oils should be their major choices. Because vegetable oil is of daily use, and there is a significant price gap between GM oils and non-GM oils, diversification of purchasing decisions should largely happen within the category of GM oils or non-GM oils. Besides, according to our previous finding, consumers' low level of perception towards vegetable oil leads to their reliance on brand. In our survey area, there is a nearly perfect correspondence between brand of vegetable oils and whether they are GM oils or not.

variable to obtain unbiased estimates. This approach recognizes that while access to mass media would raise consumers' concern over GM label, through which it may indirectly influence consumers' purchasing behavior. This is especially true in China where mass media is run by the government, and the public generally have high confidence in the reliability of information distributed via state-owned news agencies.

A regression equation for the concern over GM label is first estimated. Then predicted values of the concern variable obtained from the first-stage Probit analysis are used as an instrumental variable to replace the actual values in estimating the second-stage purchasing choice equation (Berndt, 1991).

The same set of data used by Zhong et al. (2009) is employed. It is collected from household buyers in urban Jiangsu province[9] in close cooperation with the Team of Urban Survey in Jiangsu Bureau of Statistics.[10] Nanjing, Wuxi, and Zhenjiang in south Jiangsu, Taizhou in central Jiangsu and Lian Yungang and Suqian in north Jiangsu are selected according to their disposable income per capita, geographic distribution, population and balance among sample size of different cities. A questionnaire is developed that includes questions on consumers' attitudes and behaviors towards buying vegetable oil, perception, WTP for labeling and respondents' socioeconomic background. The effective sample size amounts to 1000. We focus on the household buyers who purchase vegetable oil in supermarkets in consistency with empirical test using supermarket actual sales data. Gender ratio, average age, education background, income per capita, occupation and average family size are tested before further study and compared with aggregate socioeconomic data in Jiangsu province. All

[9] Jiangsu is selected for at least other four advantages besides its consistency with supermarket scanning sales data: First, sub-regional development pattern in Jiangsu is similar to the case of China; second, consumers' in jiangsu relatively know more about GM foods, and their response is more valuable; coastal provinces such as Jiangsu is densely populated, and the ratio of urban residents to total population is relatively higher. Its population density and urbanization is typical in future all over China; given the limited sample size, a research conducted in a specific region is more valuable than a countrywide study, because limited sample volume in several regions may result in larger research bias.

[10] Respondents are largely drawn from fixed observation spots of provincial bureau of statistics, and the deficient samples are drawn using the method of interval sampling and from different communities according to their population weighting.

of the indicators pass single-parameter test and are reliable and consistent with the overall conditions in Jiangsu province.[11]

3 GM FOOD LABEL AND CONSUMERS' PURCHASING BEHAVIOR: AN INDIVIDUAL CONSUMERS' PERSPECTIVE

3.1 Descriptive Analysis of Consumers' Concern over GM Food Label

Table 1 presents the general distributions of characteristics of our respondents. It includes all consumers who buy vegetable oil in supermarket or not. 787 samples out of 1000 samples in our survey regularly purchased vegetable oil in supermarket in 2005.

Table 1 Distributions of Socioeconomic and Demographic Characteristics of Urban Residents in the Household Survey (n=1000)

Demographic Characteristics	Classification	Frequency	Percentage	Mean and Standard Deviation
Gender	Male	353	35.3%	
	Female	647	64.7%	
Age	20-39 (youth)	281	28.1%	Mean=47.78 Std.Dev.=12.7
	40-59 (middle age)	518	51.8%	
	60- (senior citizen)	201	20.1%	
Education	Less than high school	417	41.7%	
	High / technical school	348	34.8%	
	Junior college	146	14.6%	
	Undergraduate	85	8.5%	
	Graduate or above	4	0.4%	
Income per capita	Less than 800RMB	335	33.5%	
	800-1500RMB	354	35.4%	
	1500-3000RMB	229	22.9%	
	3000-5000RMB	82	8.2%	
Permanent Residents				Mean=3.095 Std.Dev.=0.98
Have Child	Yes	507	50.7%	
	No	493	49.3%	
Allergy or not	Yes	68	6.8%	
	No	932	93.2%	

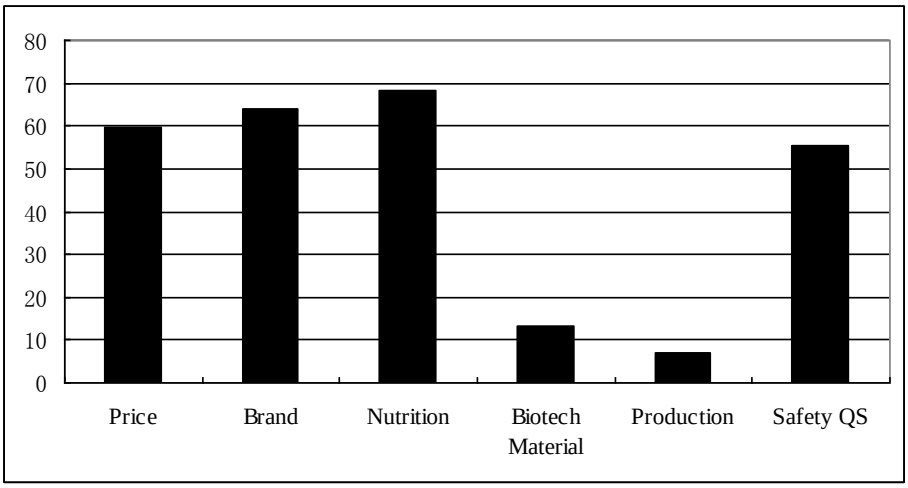
Source: calculated from 2003-2005 urban household survey data.

Comparing Figure 2 and Figure 3, concern over GM material and concern over GM food label show consistent results in percentage. Concerning consumers in supermarkets, only 13.2 percent of consumers

[11] Please refer to the *Statistic Year Book of Jiangsu 2006*.

have concern over GM material when making their purchasing decisions, lower than concern over price, brand, and nutritional ingredients. Similarly, 86 percent of consumers in supermarket have concern over food label, but among them only 13 percent have concern over GM material information printed on the label, much lower than concern over price label, brand label, and nutritional ingredients label.

Figure 2 Consumers' Concern over Purchasing Vegetable Oil (Percentage)



Source: calculated from 2003-2005 urban household survey data.

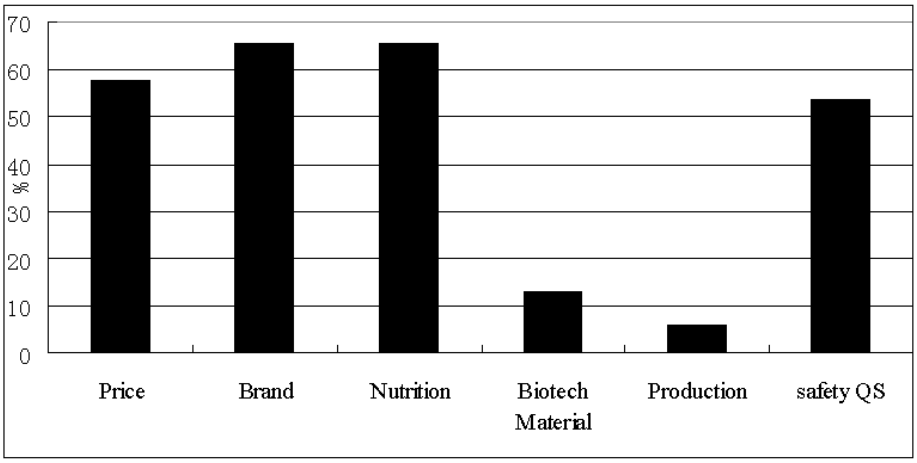
If the two concerns are significant in influencing consumers' decision making, we expect a mild decrease in the market share of GM oil as the result of label enforcement. This anticipation has been verified in the analysis of aggregate sales data collected from POS machines in supermarkets (Zhong et al., 2006). Whether it is true with individual consumers' survey data still needs to be tested, which summarizes our work in the following session.

3.2 Empirical Analysis: An Instrumental Variable Approach

Confining our research focus on consumers in supermarkets in consistency with previous actual sales data, we are able to draw much more valuable conclusions linking individual level data and market level data. Regression equations for the concern over GM food label and concern over GM material are first estimated respectively through a first-stage Probit model (Model1-Model4). Explanatory variables include consumers' demographic and socio-economic variables, size of

the residing city, as well as access to mass media (Mdaccess), including internet, TV, radio, newspaper, and magazine. Model 1 and Model 2 are the first-stage equation used to describe the consumers' choice in 2005, after the enforcement of GM labeling policy. Model 3 and Model 4 are used to describe consumers' choice change from the absence of GM labeling in 2003 to 2005.

Figure 3 Consumers' Concern over Food Label (Percentage)



Source: calculated from 2003-2005 urban household survey data.

Access to mass media is the most significant variable affecting consumers' concern over GM food label and GM material (Table 2). That is, consumers having convenient access to media are more likely to have special concern over GM label and GM material. In addition, the higher income level (i.e. above 3000RMB household income per capita) is associated with greater concern over GM label and material. People who have received higher Education are more likely to have some concern over GM label. The young and the old people have statistically significant concern over GM food label and material. Wald test of exogeneity for all the four models reject the exogeneity of concern over GM food label (Gmolabel) and concern over GM material (Gmo), which means endogeneity significantly bias our statistical estimation.

The second-stage models on purchasing decisions are estimated through binary Probit analysis using predicted values of the variable concern over GM food label or concern over GM material from the first-stage equations. The instrumental variable access to media is chosen as it is highly correlated with the concern variables but not

directly correlated with the error term in the purchasing decisions equations. This is especially true in China where the mass media is dominated by the official news agency and people highly believe in the government (Chen and Harris, 2008).

Table 2 First-Stage Estimation on Concern over GM Label and GM Material

Explanatory Variable	Dependent Variable			
	Model 1 GM Label	Model 2 GM Material	Model 3 GM Label	Model 4 GM Material
Gender	-.0234	-.0223	-.0226	-.0079
	(-0.96)	(-1.01)	(-0.76) ***	(-0.30)
Age	-.0110	-.0143	-.0126	-.0172
	(-1.77) *	(-2.56) ***	(-1.66) *	(-2.56) ***
Age*Age	.0001	.0001	.0001	.0002
	(1.60)	(2.37) **	(1.50)	(2.40) **
Education	.0244	.0049	.0308	.0019
	(1.78) *	(0.39)	(1.85) *	(0.13)
Child	-.0042	-.0060	-.0204	-.0065
	(-0.16)	(-0.26)	(-0.65)	(-0.24)
Income2	.0280	.0250	.0177	.0195
	(0.94)	(0.93)	(0.49)	(0.61)
Income3	.0267	-.0265	.0344	-.0037
	(0.78)	(-0.87)	(0.83)	(-0.10)
Income4	.0980	.0428	.1069	.0368
	(1.98) **	(0.96)	(1.76) *	(0.69) ***
Bigcity	-.0172	.0073	-.0019	.0133
	(-0.72)	(0.34)	(-0.06)	(0.51)
Mdaccess	.1262	.0944	.1257	.0978
	(5.11) ***	(4.24) ***	(4.21) ***	(3.72) ***
Constant	.2872	.4018	.3276	.4604
	(1.80) *	(2.80) ***	(1.69) *	(2.70) **
Number of Obs.	n=787	n=787	n=570	n=570
Prob > chi2	0.0000	0.0000	0.0000	0.0000

Source: empirical results using 2003-2005 urban household survey data.

Note: [1] *, **, and *** denote statistically significant at 10%, 5%, and 1%, respectively. Figures in parentheses are absolute values of t-ratio. [2] Models 1-2 are estimated based on all households that purchase edible oil in supermarkets; Models 3-4 are based on all households that purchase GM edible oil in supermarkets in 2003.

There are also large variations in the degree of media access due to the huge difference among the surveyed cities in urbanization stages.[12]

[12] The development stages for the six cities in North Jiangsu, Central Jiangsu and South Jiangsu are very typical and widely regarded to resemble Western China,

Meanwhile, the similar IV strategy is applied in Lin et al. (2006b), which focuses on estimating consumers' hypothetical acceptance of biotech food, including biotech soybean oil, input-trait and neutraceutical biotech rice, and Livestock products fed by biotech corn. Lin et al. (2006b) finds that the IV approach gives similar results to Generalized Polytomous Logit (GPL) model and conventional Probit model.

As are shown in Table 3, Model 5, Model 6, Model 7, and Model 8 are used to describe how relevant factors influence consumers' decisions. Concerning buyers' characteristics, contrary to statements in the literature, men are not shown to be prone to buy GM oil compared with women. The quadratic relation between age and purchasing decisions indicates that the young and the old are more likely to avoid buying GM oil, as compared with the middle aged people. It may result from more sensitive attitudes towards negative information among young people, while the old are more sensitive towards potential health related issues. Concerning household socioeconomic factors, results show that respondents in higher income categories are more likely to buy non-GM oil. Compared with people of low income, the budget share of vegetable oil in total expenditure is lower among the rich, which may make the rich choose non-GM oil.

Our focus is whether there is evidence from individual consumers' perspective that the enforcement of labeling policy has had an effect on consumers' purchasing choices. It is found that consumers who have special concern over GM food label (indicated by Gmolabel) or GM material (indicated by Gmo) when making their purchasing decisions are prone to choose non-GM oil. This also implies that consumers' attitudes towards GM foods are not only affected by their immediate economic interests, but their inclination to avoid risks (Hallman et al., 2002). Results of the instrumental variable approach show larger beta-coefficients of the concern variables than those obtained from the conventional Probit models, where actual values of the concern variables are used in estimating the likelihood of consumers' purchase of GM oils. However, standard errors of the coefficients obtained from the instrumental variable are larger than those obtained from the conventional approach. Finally, concerns over GM food label and GM

Central China and Eastern China that need at least several decades to catch up each other.

material are used to validate each other, as they should have consistent effects upon consumers' purchasing decisions.

Table 3 Second-Stage Estimation on Consumers' Purchasing Decisions in 2005

Explanatory Variable	Dependent Variable			
	Whether regularly buy GM oil (1=Buy, 0=Not Buy)			
	Model 5 Probit	Model 6 IV Probit	Model 7 Probit	Model 8 IV Probit
Gender	.1363	.1023	.1314	.0865
	(1.31)	(1.02)	(1.26)	(0.86)
Age	.0697	.0452	.0673	.0309
	(2.76) ***	(1.63)	(2.65) ***	(1.01)
Age*Age	-.0007	-.0005	-.0007	-.0004
	(-2.92) ***	(-1.84) *	(-2.82) ***	(-1.21)
Education	-.1153	-.0471	-.1200	-.0753
	(-2.08) **	(-0.75)	(-2.17) **	(-1.29)
Child	.0625	.0678	.0634	.0604
	(0.57)	(0.66)	(0.58)	(0.59)
Income2	-.1650	-.0952	-.1609	-.0823
	(-1.28)	(-0.75)	(-1.24)	(-0.65)
Income3	-.2481	-.1487	-.2639	-.2433
	(-1.71) *	(-1.01)	(-1.82) *	(-1.77) *
Income4	-.5714	-.3262	-.5791	-.3819
	(-2.84) ***	(-1.41)	(-2.88) ***	(-1.70) *
Bigcity	.3031	.2674	.3138	.3031
	(3.00) ***	(2.66) ***	(3.09) ***	(3.09) ***
Gmolabel	-.2235	-1.6596	-	-
	(-1.59)	(-2.85) ***		
Gmo	-	-	-.3658	-2.128
			(-2.35) **	(-3.08) ***
Constant	-.7273	.4018	-.6500	.2017
	(-1.12)	(2.80) ***	(-1.00)	(0.28)
Number of Obs.	n=787	n=787	n=787	n=787
Prob > chi2	0.0000	0.0000	0.0000	0.0000

Source: empirical results using 2003-2005 urban household survey data

Note: [1] *, **, and *** denote statistically significant at 10%, 5%, and 1%, respectively. Figures in parentheses are absolute values of t-ratio. [2] Models 5-8 are estimated based on all households that purchase edible oil in supermarkets.

What make people change from buying GM oil to non-GM oil?[13] Due to the similar length, starting point, and ending point of household survey data as compared with retail sales data, the estimate of

[13] 548 samples in our survey purchased GM oil in supermarkets in 2003, which changed to 560 samples in 2005. 78 consumers switched their purchasing decisions to non-GM oil in supermarkets.

individual consumers' decisions and their changes using household survey data acts as a further proof of the results we obtained from actual sales data. As are presented in Model 9, Model 10, Model 11, and Model 12, respondents in higher income categories are statistically significant in shifting from GM oil to non-GM oil.

Table 4 Second-Stage Estimation on Changes of Consumers' Purchasing Decisions between 2003 and 2005

Explanatory Variable	Dependent Variable			
	Whether switch from GM oil to non-GM oil (1=Yes, 2=No)			
	Model 9 Probit	Model 10 IV Probit	Model 11 Probit	Model 12 IV Probit
Gender	-.0175	.0037	-.0176	-.0172
	(-0.12)	(0.03)	(-0.12) ***	(-0.13)
Age	-.0948	-.0583	-.0900	-.0371
	(-2.67) ***	(-1.48)	(-2.52) **	(-0.85)
Age*Age	.0010	.0006	.0009	.0004
	(2.76) ***	(1.62)	(2.60) ***	(0.98)
Education	.0422	-.0408	.0724	.0316
	(0.53)	(-0.51)	(0.93)	(0.44)
Child	.1762	.1528	.1599	.1133
	(1.10)	(1.06)	(0.99)	(0.79)
Income2	.4995	.3629	.4915	.3315
	(2.26) **	(1.69) *	(2.22) **	(1.52)
Income3	.6443	.4357	.6647	.5015
	(2.71) ***	(1.74) *	(2.80) ***	(2.07) **
Income4	1.093	.6558	1.1187	.7556
	(3.74) ***	(1.73) *	(3.84) ***	(2.07) **
Bigcity	.2101	.1422	.2017	.0989
	(1.41)	(1.02)	(1.35)	(0.69)
Gmolabel	.5556	2.1972	-	-
	(3.14) ***	(3.54) ***		
Gmo	-	-	.6785	2.6487
			(3.45) ***	(3.75) ***
Constant	.0853	-.4454	-.0751	-.9793
	(0.10)	(-0.54)	(-0.08)	(-1.13) **
Obs.	n=570	n=570	n=570	n=570
Prob > chi2	0.0000	0.0000	0.0000	0.0000

Source: empirical results using 2003-2005 urban household survey data.

Note: [1] *, **, and *** denote statistically significant at 10%, 5%, and 1%, respectively. Figures in parentheses are absolute values of t-ratio. [2] Models 9-12 are estimated based on all households that purchase GM edible oil in supermarkets in 2003.

Besides, the statistic significance of concern over GM food label and GM material both imply that labeling could trigger a decrease in purchasing GM oil, which is consistent with our findings that the

market share of GM oil reduced by 4 percent right after the labeling enforcement. However, the supermarket industry in urban China boom rapidly, which means more and more consumers start buying vegetable oil in supermarket. This ongoing trend will certainly dampen the decreasing market share of GM oil, as those newcomers have relatively lower income and prefer GM oils to non-GM oils. We will come to this issue later.

Table 5 shows marginal effects of the explanatory variables that are relatively significant on the probability of purchasing GM oils and decision change from buying GM oil to non-GM oil. The marginal effects are the impacts of a per-unit change in explanatory variables on the probability of change in dependent variable, measured at mean values of the dependent and explanatory variables. In general, consumers who have concern over GM food label are 7.5 percent less likely to buy GM oil, and they are 10.5 percent more likely to switch from buying GM oil to non-GM oil. Similarly, concern over GM material lowers the likelihood of buying GM oil by 12.3 percent, and increase the probability of decision change by 12.7 percent.

The results here, however, may suffer from omitted variable bias. Though media access has been utilized as an instrument variable for our mainly focused labeling effect indicator, i.e. concern over GM oil label and concern over GM material, unobservable household preferences over GM food may still affect vegetable oil purchasing decisions and are correlated with some household socioeconomic factors.[14] For instance, the unobserved household preference may lead to an overestimate of the negative income effect and the negative education impact on choosing GM oil. Moreover, the quadratic age effects may also be biased upward. Before conducting further robustness check, occupation dummies are added to the models aiming at capturing consumers' preferences. Household heads that are in the research/education and government sectors are put into the same category since previous studies consistently show that more knowledge or inside information may affect consumers' preferences. However, the basic results do not vary with occupation dummies and are not reported here.

A further robustness check is thus conducted (Appendix 1). Ideally, fixed effect (FE) panel data model should be used to control for time-

[14] We appreciate one referee for pointing out this issue.

invariant household preferences. However, due to the limitation of the dataset, we only have one year (i.e. 2005) information on household per capita income and concern over GM label and GM material.

Table 5 Marginal Effects-Changes in the Probability of Purchasing Decisions

Explanatory Variable	Marginal Effects			
	Model 6	Model 8	Model 10	Model 12
Gender	-	-	-	-
Age	.0234	.0226	-.0178	-
Age*Age	-.0003	-.0002	.0002	-
Education	-	-	-	-
Child	-	-	-	-
Income2	-	-	.0939	.0919
Income3	-	-.0886	.1211	.1243
Income4	-.1920	-.1944	.2055	.2093
Bigcity	.1018	.1054	-	-
Gmolabel	-.0751	-	.1045	-
Gmo	-	-.1228	-	.1269

Source: Calculated from 2003-2005 urban household survey data.

Fixed effect model is inappropriate here, as these key variables will otherwise be differenced out. A random effect (RE) model can be used to check the robustness of our previous estimations. One major advantage of RE model over either FE model or first differencing (FD) model is that it allows for explanatory variables that are constant over time, but it is unbiased only when the unobserved fixed effect is uncorrelated with other explanatory variables. Even if this strong assumption is not satisfied in our case, i.e.household preferences might be associated with household socioeconomic variables, random effect models might still be helpful in robustness check when they approximate fixed effect models rather than pooled data models.[15]

[15] In a standard GLS RE model, λ is defined to generate quasi-demeaned data through weighing time averages in each group by λ. RE models are then estimated based on the quasi-demeaned data. RE estimators are closer to FE estimators when λ is closer to 1, while it is closer to pooled data estimators when λ is closer to 0 (Wooldridge, 2001). Define an unobserved effect model as:

$y_{it} = \beta_0 + \beta_1 x_{it1} + ... \beta_k x_{itk} + a_i + u_{it}$, where $\sigma_a^2 = \mathrm{Var}(a_i)$ and $\sigma_u^2 = \mathrm{Var}(u_i)$

Further defining $\lambda = 1 - \sqrt{[\sigma_u^2/(\sigma_u^2 + T\sigma_a^2)]}$, a RE model transformation is conducted,

$y_{it} - \lambda\overline{y_i} = \beta_0(1-\lambda) + \beta_1(x_{it1} - \lambda\overline{x_{i1}}) + ... + \beta_k(x_{itk} - \lambda\overline{x_{ik}}) + [(1-\lambda)a_i + u_{it} - \lambda\overline{u_i}]$,

where the overbar in the RE model denotes time average for each i. In the Appendix, robustness checks using both pooled data models and RE models are presented. The estimated λ is closer to 1, suggesting the RE estimations approximate FE models to

Moreover, RE models with IV strategy are applied in model 6' and Model 8', which aims to dealing with the potential correlation between the disturbance term and other explanatory variables.

Results from robustness check verify upward biasness of some household socioeconomic factors in shaping purchasing decisions (Appendix 1). However, major results still follow, for instance, the quadratic household head age effect, income and education effect. The year fixed effect is negatively significant, suggesting a saliently decreasing year trend. More importantly, concern over GM label and GM material has smaller but still negatively significant impact on household purchasing decisions. Consumers who have concern over GM food label are 4.1 percent less likely to buy GM oil, while concern over GM material lowers the probability of buying GM oil by 9.8 percent.

4 CONCLUSIONS AND POLICY IMPLICATIONS

This paper utilizes household survey data on GM vegetable oil consumption between 2003 and 2005 to further examine whether GM food labeling has an impact on consumers' vegetable oil purchasing decisions. Direct variables indicating consumers' response to label regulation are employed to test labeling effect. Endogeneity issues impeding label effect measurement are addressed.

The empirical results support our previous finding that in the short run the market share of GM oil decreased significantly by a small amount as a result of labeling enforcement. The probability of regularly purchasing GM oil for supermarket customers who have concern over GM label is lower by 4.1-7.5 percentages after labeling enforcement, depending on different empirical modeling. Likewise, the probability of regularly purchasing GM oil for households who have concern over GM material is lower by 9.8-12.3 percentages. The probability for switching from buying GM oil to non-GM oil in the supermarkets is higher by 10.5 percent for households that concern GM label, while it is higher by 12.7 percent for households that concern GM material.

The link between concern over GM label/material and GM oil market share directly addresses the effectiveness of labeling policy-making as

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some degree. Given the limitation of the dataset, household preferences fixed effect models are left for future study when dataset with richer information on over-time variations becomes available.

well as business strategy. Though aimed at informing domestic consumers on their food consumption, the fact that China has been the world's largest importer of GM products (USDA, 2006) and the sixth-ranked country in GM crop production (James, 2006) lends labeling policy itself to have global impact. Meanwhile, GM oil consumption growth in China in the last two decades has been compensated by fast growth in net imports, while domestic production has been stagnated (USDA, 2007). Therefore, no matter in terms of stock or flow, welfare analysis for China's international trading partners of GM products should be conducted. For example, the U.S. government and farmers growing herbicide-tolerant soybeans have been concerned about recent labeling policy shift in China, and researchers in USDA have been engaged in many general/partial equilibrium analyses on welfare distribution among interest groups in the U.S. This policy shift mainly affects soybeans imported from the United States and South America, because GM soybeans production is not allowed in China.

The labeling policy also matters to domestic trade and production, as many farmers in the North China Plain and Northeast China are employed in the non-GM soybean sector. Any major move in labeling policy might influence non-GM soybean supply and unemployment rate via demand for GM/non-GM soybeans. Besides, vegetable oil manufacturers want to know how sensitive consumers are towards GM products and how their purchasing decisions differ by household socioeconomic characteristics. Marketing based on effectively targeting potential customers will smooth the labeling policy shock and maximize profit.

5 GM LABEL AND MARKET TREND: WHAT SHOULD WE KNOW

This paper aims at identifying the effect of GM food labeling. However, following Zhong et al. (2006), Lin et al. (2006c), a study (Zhong and Chen, 2009) using aggregate retail scanning data from POS machines and a test of individual households' decision-making in this paper, can we conclude that consumers care about GM food label? Unfortunately, it might not be the case, since all these studies only point to the market trend in the short run, while potential long-term market trends affected by a series of dynamic factors are open for discussion.

Some areas regarding the impact of GM food label on market trend are still underexplored, including discrepancy between stated preferences and revealed preferences, influencing factors for long-term market trend, trend for aggregate market share incorporating supermarket and other market channels, data compatibility, other marketing strategies, and more fundamentally who make purchasing decisions.

First of all, what types of datasets are in greater need to capture consumers' actual choices and market condition? Empirical results employing stated preferences might show discrepancy between concern over food safety and purchasing behavior. Attempts to infer market trend from concerns over food safety induce biases. Previous studies find that consumers in China express even greater concern over food safety than their counterparts in developed countries. However, a large portion of them choose to buy food in the market which they believe unsafe. Factors other than concern over food safety, such as belief in governmental food safety regulation and food label, concern over price, knowledge of GM food, strategic behavior, and convenient to buy food or not, also play important roles. All these factors are revealed in consumers' actual choices, but might not in their stated preferences. Thus, empirical researches applying actual sales (purchasing) data deliver more reliable policy implications.

However, in many circumstances we have to apply survey data of stated preferences, leading us to explore factors influencing the discrepancy between stated preferences and revealed preferences and make proper adjustment before drawing policy implications. If we believe that the discrepancy comes from differences in consumers' abstract cognition and their real world perception, then we need to further explore the effects of consumers' socioeconomic characteristics and concern over food safety on the probability of discrepancy. For instance, higher level of education and/or more similar beliefs in food safety across different market channels might be accompanied by larger discrepancy. Distinguishing questions targeting consumers' abstract cognition and their real world perception is crucial when designing questionnaires. An update of this kind of analysis is also needed as stated preferences and revealed preferences might get closer.

Second, neither actual sale data from POS machine nor urban household survey employed here can safely aid us in implying the market trend in the long run. One, for both datasets they only covers time period between 2003 and 2005, a few months before and after the

labeling enforcement. In contemporary China, consumers' attitudes and purchasing decisions towards GM foods are not stable and prone to change. To study whether the influence of regulation policy on the market share would stabilize, we need to further expend the duration of this sample. Meanwhile, rapid structural change over time in China supermarket industry catering to consumers' needs motivates us to expand the sample duration.

Two, structural differences in supermarkets across regions (and locations) over time suggest an expansion of the analysis. It is believed that the labeling impact would be smaller (or the market share of GM oil might even rise in the near future) if this analysis is extended to incorporate more consumers in smaller-sized cities and rural areas as well as more people with faster life pace. In general, the changes of GM oil market share are affected by the structural effect of the rich and at the same time the gross consumption effect of the poor. Following economic growth, more and more people in urban areas will shift their edible oil purchases from street market to supermarket, and the probability of buying GM-oil may increases as newcomers are most likely to be in low-income groups; following rapid urbanization, more and more farmers will shift their consumption from locally produced and processed non-GM oils (China has not permitted growing GM oil crops) to those produced and processed elsewhere, and the majority might be GM oil because of its much lower price; following economic growth and more efficient life pace, more and more people will dine out and/or eat manufactured food, restaurants and food manufacturers are more likely to use GM-oil to reduce costs.

Third, appropriate market share in focus should be the aggregate total, not that of supermarket alone. The market share is important, since it matters to the development of the whole edible oil industry. However, the available datasets still cannot satisfy the prerequisite of studying different consumer groups and their overall effect towards the market trend. More precise study may require information on the market share of edible oil purchased outside supermarket, as well as on the market share of edible oil purchased by non-individuals inside supermarket.

Further, our datasets available are not perfectly compatible mainly due to four reasons. To begin with, the actual sales data in supermarkets comprises all individual buyers and other social entities, while household survey data only includes individual consumers; second, large volume purchases from enterprises often crowd out buying

activities of individuals;[16] third, consumers of high income would diversify their vegetable oil consumption. This nutritional consideration will definitely complex the calculation of market trend. Furthermore, with rapid income growth, more and more people dine out. This gradual structural change of food consumption would be followed by the reduction of household vegetable oil consumption but increasing chances of dining out. Finally, the shrinking family size in modern society also contributes to this process. Overall, the lack of considering other social entities purchasing decisions, crowd out effect, consumption diversification, dining out trend, and family size shrinking effect would underestimate the market share of GM oil.

The reasons for non-perfect compatibility of the datasets raise a fundamental question on who make real decisions. Researches might not simply assume that consumers themselves make all independent decisions any more. Therefore, it is important to examine the applicability of household food survey data at hand before inferring the aggregate market trend involving collective consumption, dining out and so on.

Finally, GM food labeling is only one way to provide information, other marketing strategies taken by stores and manufacturers that may affect the sales of vegetable oils have not been considered due to limitation of datasets. This includes advertisement, sales promotion and so on. We should study all the major marketing strategies and their impacts on the market before drawing final conclusions.

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[16] Related to the first two points that might lead to data incompatibility and underestimation of the market share of GM oil, group purchase of edible oil by big institutions as in-kind benefit to staff is likely to be GM oil. However, it may gradually reduce as cash income is more preferred.

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APPENDIX

Estimation on Consumers' Purchasing Decisions using RE Model

Explanatory Variable	Dependent Variable: Whether regularly buy GM oil (1=Buy, 0=Not Buy)			
	Model 5' Pooled Probit	Model 6' Panel+IV Probit	Model 7' Pooled Probit	Model 8' Panel+IV Probit
Gender	.0430* (0.07)	.0192 (0.23)	.0433* (0.07)	.0143 (0.40)
Age	.0149*** (0.01)	.0076* (0.09)	.0153*** (0.01)	-.0001 (0.99)
Age*Age	-.0002*** (0.01)	-.0001* (0.05)	-.0002*** (0.00)	-.0000 (0.95)
Education	-.0311** (0.01)	-.0128 (0.21)	-.0324*** (0.01)	-.0159* (0.10)
Child	.0292 (0.24)	.0162 (0.37)	.0287 (0.25)	.0361 (0.12)
Income2	-.0405 (0.17)	-.0224 (0.34)	-.0419 (0.15)	-.0508* (0.07)
Income3	-.0696** (0.03)	-.0459 (0.14)	-.0713** (0.03)	-.0541* (0.09)
Income4	-.1239*** (0.01)	-.1184* (0.08)	-.1278*** (0.01)	-.1295* (0.06)
Bigcity	.1183*** (0.00)	.0736*** (0.00)	.1180*** (0.00)	-.0010 (1.00)
Gmolabel	-.0358 (0.17)	-.0405*** (0.01)	-	-
Gmo	-	-	-.0201** (0.04)	-.0980*** (0.01)
Year	-.0703*** (0.00)	-.0436*** (0.00)	-.0705*** (0.00)	-.0426*** (0.00)
Number of Obs.	1574	1574	1574	1574
Prob > chi2	0.0000	0.0000	0.0000	0.0000
λ (1=FE, 0=Pooled)	-	.749	-	.728

Source: Empirical results using 2003-2005 urban household survey data.

Note: [1] *, **, and *** denote statistical significance at 10%, 5%, and 1%, respectively. Figures in parentheses are p values. [2] Models 5'-8' are estimated based on all households in years 2003 and 2005.