Are Urban Consumers in China Ready to Accept Biotech Foods?

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Are Urban Consumers in China Ready to Accept Biotech Foods?

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On January 5, 2002, China's Ministry of Agriculture (MOA) issued specific regulations for agricultural transgenic products. A part of these regulations calls for MOA regulatory approvals for domestic release of these products. At present, the Chinese government is pondering whether to commercialize biotech rice. Yet the economic impacts of introducing biotech rice critically depend in part on the degree of market acceptance—a high level of acceptance would ensure greater benefits to Chinese rice producers and consumers, and vice versa.

In addition, the regulations require labeling of biotech products. The decision by food manufacturers and retailers in using and labeling biotech foods depends on consumer attitudes. If the majority of Chinese consumers are indifferent between biotech and non-biotech foods, food manufacturers and retailers are more prone to use less costly biotech ingredients and label food products accordingly. Otherwise, they would be more inclined to use identity-preserved non-biotech ingredients in their food processing to avoid biotech labeling, which adds extra costs.

Despite the significant role of consumer attitudes in the economic impacts of biotech commercialization and biotech labeling decisions, as well as trade implications, only a few studies have addressed this research issue in China (Li, *et al*.; Zhong, *et al*.). Previous studies focused on specific cities, such as Beijing or Nanjing. Up to now, except for two dissertations (Bai; Qui) which are based on large-scale consumer surveys, there are only few studies available that address consumers' willingness to pay (WTP) for biotech foods in China (Li *et al*.). Even though there have been an increasing number of studies that address consumers' WTP for non-biotech foods in Japan, Norway, Taiwan and the United States (Chern and Rickertsen; Kaneko and Chern; Chiang), it is not certain that these results are applicable to consumers in China.

The main purposes of this study are: 1) to provide an assessment of consumer acceptance of biotech foods in China, and 2) to estimate Chinese consumers' mean WTP for biotech foods. Analysis of consumer

attitudes focuses on biotech soybean oil, input- and output-trait biotech rice, and livestock products fed with biotech corn, while WTP analysis is limited to biotech soybean oil and insect-resistant biotech rice.

Previous Related Studies

Information obtained from previous surveys suggested that the majority of Chinese consumers have favorable opinions about biotech foods. (Li, *et al*.; Zhong, *et al*.). In their survey of 599 consumers in Beijing in 2002, for example, Li *el al*. found that nearly 70 percent of the respondents had either favorable or neutral opinions about biotech foods, and less than 10 percent of them had a negative opinion. Of all the respondents, a great majority were willing to purchase *product-enhancing* (output-trait) biotech rice and biotech soybean oil at the same price as the non-biotech products. In contrast, another survey found that respondents from Japan and Taiwan were not as supportive of biotech foods as in the United States (Chern and Rickertsen). Zhong *et al*. found that consumers who had heard about the technology were more willing to buy biotech foods (52.7%) than those who had never heard of biotechnology.

There are an increasing number of studies that address consumers' WTP in China or other Asian countries. Information obtained from previous surveys suggested that Chinese consumers were willing to pay premiums for *product-enhancing* (or *output-trait*) biotech foods. In addition, consumers in some Asian countries were willing to pay premiums for avoiding the purchase of biotech foods (and hence purchasing non-biotech foods) made from *process-enhancing* (or *input-trait*) ingredients (McCluskey *et al*., Li *et al*., and Chern and Rickertsen). For example, using student survey data that were taken during December 2000 to March 2001, Chern and Rickertsen estimated WTP for non-biotech vegetable oil at: 1) 33-40 percent for Japan, 2) 17-21 percent for Taiwan, 3) 55-69 percent for Norway, and 4) 50-62 percent for the United States.

The Consumer Attitudes Survey

In fall 2002, a sample of 1,100 consumers was selected by using a combination of stratified and random samplings. First, all samples in 11 cities were taken from five provinces or municipalities along China's

east coast (fig.1). Second, samples were stratified according to the size of the cities selected from each province. Major socio-economic indicators for responses, as shown in table 1, suggest that the selected sample is generally representative of consumers in eastern cities, but does not include consumers in rural areas or cities in central or western China (Bai; Lin *et al.*).

Awareness of Biotech Foods

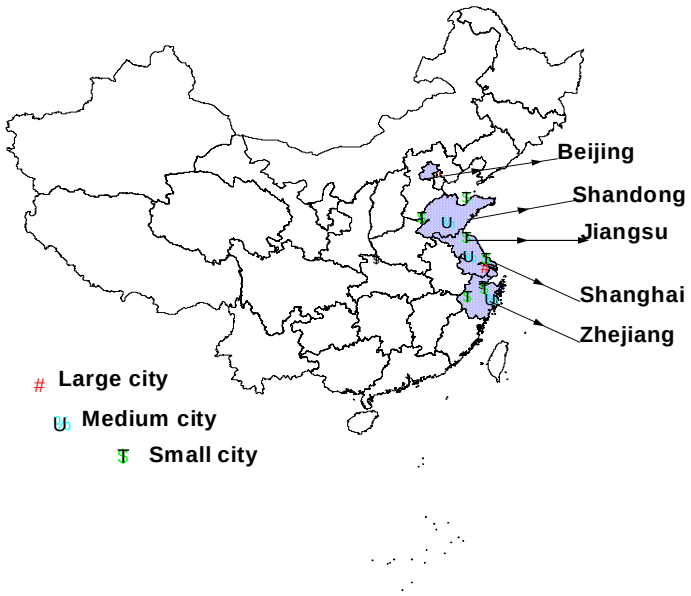
The survey found that about two-thirds of respondents had heard of biotech foods, about 10 percentage points lower than the level of awareness about biotechnology reported for the United States (International Food Information Council). Consumers who had never heard of biotech foods and those who had only heard of it on an *occasional* basis, together accounted for 77 percent of all respondents. Only about 23 percent of respondents indicated that they had *frequently* heard of biotech foods.

Biotech Food Acceptance

A majority of China's urban consumers were supportive of biotech foods. This pro-biotech group of consumers accounted for 46-67 percent of all respondents, depending on the kind of biotech foods. In contrast, 5-15 percent of urban consumers were strongly or relatively opposed to biotech foods. Figure 2 shows the pattern of consumer attitudes toward biotech soybean oil in China, which is generally applicable to other biotech foods (Bai).

The above consumer attitudes toward biotech foods were expressed without any regard for the price differential between biotech and non-biotech foods. In the context of the price differential, the majority of respondents–58.3 to 74.1 percent–were willing to purchase biotech foods if the prices were identical between biotech and non-biotech foods (that is, Pgm = Pngm), depending on the kind of foods. The range was narrowed to 60.0-67.9 percent for soybean oil and rice (fig. 3). An even greater majority–67.0 to 80.9 percent–were willing to purchase biotech foods if a 10-percent price discount (that is, Pgm = 0.9 Pngm) was offered to them. A small but significant

Figure 1. The distribution of survey samples across five provinces or municipalities in China



minority—about 20 percent—of urban consumers were not willing to purchase biotech foods regardless of any price discounts (Bai).

Methodology

A starting point of modeling consumer acceptance of biotech foods is the estimation of an ordered probit model that ranks consumers' response into the following sequential order: 1) strongly acceptable, 2) relatively acceptable, 3) neutral, 4) relatively unacceptable, and 5) strongly unacceptable (Bai). This model is then refined through the *instrumental variable* estimator, which is the focus of modeling consumer attitudes toward biotech foods in this study. In addition, a dichotomous choice model is used to estimate mean WTP through the contingent valuation method.

Consumer Acceptance

The *instrumental variable* method recognizes that, while access to mass media would raise consumer awareness of biotech foods, media access also influences consumer attitudes toward these products. As a result, the *awareness* variable in the conventional acceptance equation becomes interdependent with the

Table 1. Summary statistics for demographic and perception variables

Variable	Mean	Standard deviation	Minimum	Maximum
Gender	0.41	0.49	0 (female)	1 (male)
Age	46.55	12.47	16	80
Education (yrs)	11.08	2.94	1	18
Household size	2.98	0.76	1	7
Monthly per capita disposable income (rmb)	844.19	416.12	100	3003
Residing city: (%)				
Small city	30.3	0.46	0	1
Medium city	29.9	0.46	0	1
Large city	39.8	0.49	0	1
Occupation: (%)				
Government	3.18	0.42	0	1
State enterprises	19.10	0.42	0	1
Commercial	26.57	0.44	0	1
Unemployed	8.46	0.28	0	1
Retired &others	25.77	0.28	0	1
Role of food shopping: (%)				
Major decisionmaker	57.51	0.49	0	1
Co-decisionmaker	15.22	0.36	0	1
Little or no role	27.26	n.a.	0	1
Awareness of biotech foods: (%)				
Never heard of	33.4	0.46	0	1
Heard of (<3 yrs)	42.5	0.49	0	1
Heard of (>3 yrs)	24.1	0.43	0	1
Never heard of	33.4	n.a.	0	1
Occasionally	43.7	n.a.	0	1
Frequently	22.9	n.a.	0	1
Health condition: (%)[a]				
Better than average	38.1	0.49	0	1
About the average	47.3	0.50	0	1
Worse than average	7.2	0.26	0	1

Source: J. Bai, "Consumers' Acceptance of and Willingness to Buy Genetically Modified Foods in Urban China," M.S. thesis, Center for Chinese Agricultural Policy, Chinese Academy of Sciences, Beijing, China, June 2003.

[a]About 7.4% of respondents did not indicate their health conditions in the survey questionnaire.

Figure 2. Consumer attitudes toward biotech soybean oil in China

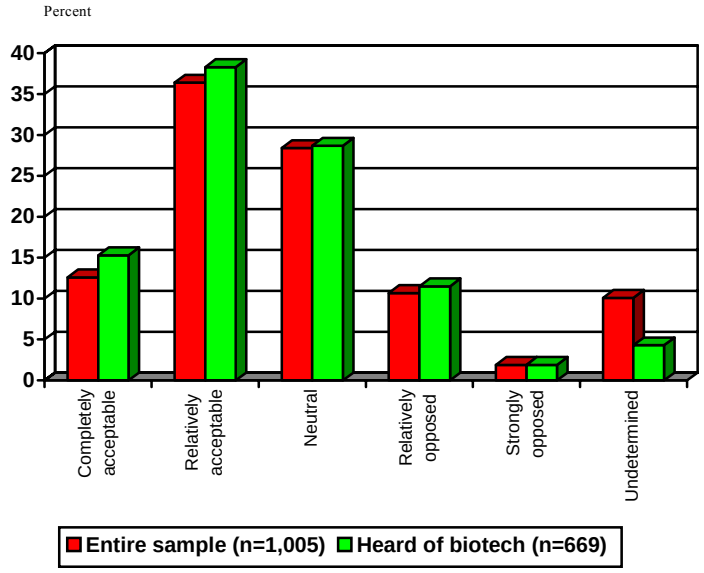
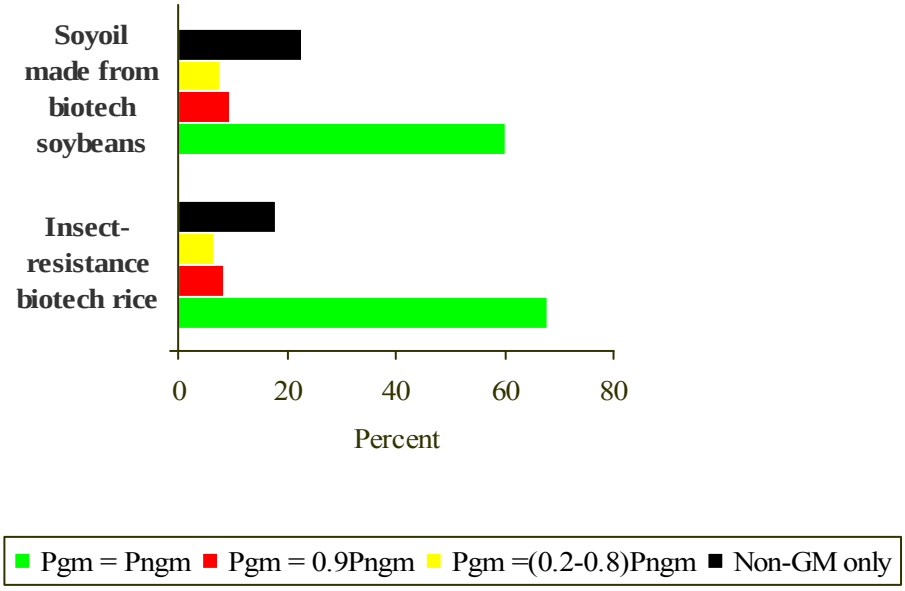


Figure 3. Chinese consumers' price discount needed to purchase biotech soyoil and rice



error term, which gives rise to biased estimates (Maddala). To address this methodological issue, an auxiliary regression equation for the *awareness* of biotech foods is first estimated. Then predicted values

of the *awareness* variable obtained from the first-stage probit analysis are used as an instrumental variable to replace the actual values in estimating the second-stage acceptance equation.

WTP: Contingent Valuation Method (CVM)

The survey questionnaire elicits consumers' bid prices through successive bids, starting with an initial bid where prices of biotech and non-biotech foods are identical. If consumers were willing to purchase biotech foods at no price discount, they would respond to the first bid by saying "yes". Otherwise, they were asked if they would purchase biotech foods if a random price discount is offered to them. A set of price discounts, including 10%, 20%, 30%, 40%, 60%, and 80%, were randomly selected on the basis of *a priori* information about the distribution of WTP from the survey, which permits us to place both an upper and a lower bound on the respondent's unknown true WTP (Hanemann *et al*., 1991). The random price discounts are inclusive of all the possible values. The survey questionnaire also captures consumers who would accept only non-biotech foods regardless of price discounts, which is part of the bidding mechanism.

There are three discrete outcomes of the bidding process that are observable: 1) a "yes" to the initial bid (B_0)—WTP is equal or less than the initial bid, that is, no price discount, or WTP$\leq B_0$=0; 2) a "no" followed by a "yes" in the second bid—WTP lies between the initial bid and a random price discount in the second bid, that is, 0<WTP<BID; and 3) "no" to both bids—WTP is greater than the random price discount in the second bid, that is, WTP>BID.

The qualitative dependent variable is expressed in terms of the probability of purchasing biotech foods to a bid amount. This model takes the form:

$$Pr\{WTP \leq BID\} = \Phi(\alpha - \rho BID + \lambda' Z)$$

where *WTP*: the minimum acceptable price discount (in percent terms) for biotech foods
BID : the bid price (in percent discount) offered to biotech foods,
Z : a set of observable characteristics for consumers,
Φ : a cumulative normal or logistic distribution function, and
α, ρ and λ : unknown parameters

The parameters are estimated using maximum likelihood method, which yields the choice probabilities by maximizing the log-likelihood function for the three discrete outcomes (Hanemann, Loomis and Kanninen; Qaim and De Janvry; McCluskey, Quchi, Grimsrud and Wahl). Following the procedure by Chern and Rickertsen, the mean WTP for the consumer to purchase the biotech food is:[1]

$$E(WTP) = 1/\rho * (\alpha + \lambda' Z)$$

Estimated Model Results

This section presents estimated results on urban consumer attitudes towards biotech foods in China based on the instrumental variable method. In addition, estimated dichotomous choice model results and mean WTP are presented.

Consumer Acceptance

The ordered probit model estimated with the instrumental variable approach takes the following general form:

$$\begin{aligned} Z= {} & \alpha + \beta_1 GENDER + \beta_2 AGE + \beta_3 EDU + \beta_4 INCOME + \beta_5 GOV + \beta_6 COM \\ & + \beta_7 UNEMPL + \beta_8 WFOOD + \beta_9 MIDCITY + \beta_{10} SMALLCITY + \beta_{11} HEAL\_BT \\ & + \beta_{12} HEAL\_OK + \beta_{13} HEAL\_WS + \beta_{14} MAJ\_DEC + \beta_{15} CO\_DEC + \beta_{16} C\_DATE \\ & + \beta_{17} HEAR\_N + \beta_{18} HEAR\_L + \beta_{19} C\_ENV + \beta_{20} BELINF + \beta_{21} C\_POV + v \end{aligned}$$

Definitions and measurement units for these variables are presented in table 2.

In the instrumental variable approach, auxiliary regression equations for the awareness of biotech foods are first estimated through a first-stage probit model. Explanatory variables include consumers' demographic and socio-economic variables, size of the residing city, as well as access to mass media (MDACCESS), including TV, radio, newspaper, and magazine. Access to mass media is regarded as the primary instrument, in addition to others. The second-stage model on acceptance of biotech foods was

[1] Mean WTP has to be carefully interpreted in the context that there are diverse consumer preferences toward biotech foods among respondents in the survey—about two-thirds of them can accept biotech foods without price discounts, less than 20 percent of respondents are sensitive to price, and about 20 percent are willing to buy only non-biotech foods.

Table 2. Definitions and measurement units of explanatory variables

Variable	Definition and unit
GENDER	1=male 0=female
AGE	years
EDU	ditto
INCOME	Per capita annual disposable income (1,000 rmb)
SHH	Per capita annual disposable income in Shanghai (1,000 rmb)
GOV	1=an occupation of working for the government or state-run enterprises
COM	1=an occupation of working for corporations or proprietary enterprises
UNEMPL	1=unemployed
WFOOD	1=an occupation of working for food processors
OTHER	1=other occupations
BIGCITY	1=residing in a large city
MIDCITY	1=residing in a medium city
SMALLCITY	1=residing in a small city
HEAL_BS	1=excellent health condition
HEAL_BT	1=better-than-average health condition
HEALTH_OK	1=about average health condition
HEALTH_WS	1=worse-than-average health condition
MAJ_DEC	1=major decisionmaker for household food purchases
CO_DEC	1=co-decisionmaker for household food purchases
NON_DEC	1= little involvement in household food purchasing decisions
C_DATE	1=paying close attention to the expiration date in food label
HEAR_N	1=have never heard of biotech foods
HEAR_S	1=have heard of biotech foods for less than 3 years
HEAR_L	1=have heard of biotech foods for over 3 years
MDACCESS	1=have access to media, including newspaper, magazine, radio, and TV
C_ENV	1=caring for environmental protection
BELINF	1=have trust in the accuracy of media information
C_POV	1=attention being given to disadvantaged groups by the government
NONOIL	1=not consuming soybean oil in the household

estimated through ordered probit analysis using predicted values of the awareness variable from the first-stage awareness equation.

Table 3 shows estimated model results for the four biotech foods. Major findings from Bai's thesis, by and large, remain intact. Income (for biotech rice), status of employment, the size of residing cities, awareness level of biotech foods, and trust in the accuracy of media information remain important factors affecting the acceptance of biotech foods. Small and mid-city consumers were more willing to accept biotech foods than large-city consumers.

Table 3. Estimated probit model results on awareness of biotech foods

Explanatory variable	Awareness of less than three years	Awareness of longer than three years
GENDER	- 0.0227	0.1334
	(0.24)	(1.36)
AGE	0.0014	-0.0012
	(0.34)	(0.29)
INCOME	- 0.0042	0.0179
	(0.40)	(1.72)*
EDU	0.0197	-0.0359
	(0.23)	(0.34)
EDU^2	- 0.0027	0.0043
	(0.71)	(0.98)
SMALLCITY	0.0752	-0.1635
	(0.57)	(1.23)
MIDCITY	0.2035	-0.3466
	(1.58)	(2.63)***
MDACCESS	1.8913	1.0785
	(16.43)***	(8.95)***
SHH	0.0188	-0.0224
	(1.72)*	(2.09)**
WFOOD	0.0979	--
	(0.47)	

[a]Figures in parentheses are absolute values of t-ratio.
* Statistically significant at 10% level of significance.
** Statistically significant at 5% level of significance.
*** Statistically significant at 1% level of significance.

Results of the *instrumental variable* estimator show larger beta-coefficients of the awareness variable for all the four biotech foods than those obtained from the conventional probit model where actual values of the awareness variable are used in estimating the likelihood of consumer acceptance of biotech foods (table 4). For example, in the case of biotech soybean, the coefficient of the awareness variable from *instrumental variable* is 2.55 times greater than that obtained from the conventional approach. However, standard errors of the coefficients obtained from the *instrumental variable* are larger than those obtained from the conventional approach.

Willingness to Pay

In this study, the dichotomous choice model is estimated for consumers' willingness to purchase soybean oil made from herbicide-tolerant biotech soybeans and insect-resistant biotech rice in China. Definitions and measurement units for explanatory variables are presented in table 5. Tables 6 and 7 show the estimated model results.

Table 4. Estimated *instrumental variable* model results on consumer acceptance of biotech foods (n=1,005)

Explanatory variable	Biotech soybean oil	Input-trait biotech rice	Neutraceutical biotech rice	Livestock products fed with biotech corn
GENDER	-0.003	-0.038	-0.061	-0.133
	(0.04)	(0.45)	(0.72)	(1.60)
AGE	0.004	0.002	0.005	0.005
	(1.16)	(0.68)	(1.31)	(1.50)
EDU	0.018	-0.018	-0.002	0.005
	(1.00)	(0.47)	(0.08)	(0.26)
INCOME	-0.006	-0.015	-0.021	-0.005
	(0.75)	(1.79)*	(2.47)***	(0.58)
GOV	0.103	0.116	0.086	0.111
	(1.07)	(1.20)	(0.87)	(1.16)
COM	0.002	0.006	-0.002	0.002
	(0.03)	(0.06)	(0.03)	(0.02)
UNEMPL	0.274	0.196	0.160	0.269
	(2.06)**	(1.46)	(1.19)	(2.03)**
WFOOD	0.122	0.334	0.398	-0.024
	(0.79)	(2.13)**	(2.50)**	(0.16)
MIDCITY	0.078	0.130	0.238	0.154
	(0.80)	(1.37)	(2.48)**	(1.64)*
SMALLCITY	0.264	0.277	0.272	0.317
	(2.78)***	(2.95)***	(2.86)***	(3.41)***
HEAL_OK	-0.033	-0.014	0.020	-0.067
	(0.45)	(0.18)	(0.26)	(0.91)
HEAL_WS	-0.193	-0.226	-0.197	-0.188
	(1.35)	(1.59)	(1.37)	(1.32)
MAJ_DEC	-0.049	-0.153	-0.011	-0.074
	(0.55)	(1.72)*	(0.12)	(0.84)
CO_DEC	-0.028	-0.064	0.062	0.093
	(0.26)	(0.58)	(0.56)	(0.85)
C_DATE	-0.186	-0.085	-0.087	-0.149
	(1.49)	(0.67)	(0.69)	(1.19)
HEAR_S	0.704	0.439	0.142	0.418
	(2.74)***	(1.71)*	(0.55)	(1.65)*
HEAR_L	-0.660	-0.069	0.735	-0.070
	(1.16)	(0.12)	(1.29)	(0.12)
C_ENV	0.054	0.071	0.132	-0.040
	(0.72)	(0.95)	(1.73)*	(0.53)
BELINF	0.206	0.290	0.282	0.152
	(2.71)***	(3.87)***	(3.71)***	(2.03)*
NONOIL	-0.564	n.a.	n.a.	n.a.
	(5.37)***			

[a]Figures in parentheses are absolute values of t-ratio. *, **, *** denote statistical significance at 10% , 5%, and 1% levels.

Price discounts offered to the respondent for purchasing biotech foods, BIDSOYOIL and BIDRICE, have expected negative sign and are highly statistically significant. Given these bid prices being negative numbers, a coefficient with a negative sign means that as price discounts offered to respondents for purchasing biotech foods increase, the respondents would be more willing to purchase biotech soybean oil and biotech rice. Residents of small cities and the unemployed were more willing to

Table 5. Definitions and measurement units of the explanatory variables

Variable	Definition and unit
BIDOIL	Ultimate bid prices (in percent discounts) offered for biotech soyoil
BIDRICE	Ultimate bid prices (in percent discounts) offered for biotech rice
GENDER	1=male 0=female
INCOME	Per capita annual disposable income (1,000 rmb)
UNEMPL	1=unemployed
SMALLCITY	1=residing in a small city
AWARENESS	1=have heard of biotech foods
BELINF	1=have trust in the accuracy of media information
NO-SOYOIL	1=not consuming soybean oil in the household

Table 6. Estimated dichotomous choice model results for biotech soyoil in China (sample size=1,005)

Variable	Coefficient	Standard error
Intercept	1.586	0.182***
BIDOIL	-2.711	0.154***
SMALLCITY	0.234	0.126*
UNEMPLOYMENT	0.373	0.217*
BELINF	0.157	0.112
AWARENESS	-0.106	0.107
INCOME	-0.029	0.011***
GENDER	0.193	0.108*
NO-SOYOIL	-0.631	0.145***

*,**,*** Statistically significant at 10%, 5%, and 1% level, respectively.

Table 7. Estimated dichotomous choice model results for biotech rice in China (sample size=1,005)

Variable	Coefficient	Standard error
Intercept	1.507	0.172***
BIDRICE	-1.846	0.142***
SMALLCITY	0.269	0.121**
UNEMPLOYMENT	0.436	0.219**
BELINF	0.091	0.105
AWARENESS	-0.166	0.100*
INCOME	-0.027	0.010***
GENDER	0.121	0.102*

*,**,*** Statistically significant at 10%, 5%, and 1% level, respectively.

purchase biotech soybean oil and biotech rice than those living in larger cities and the employed. Mean WTP–average price premiums (in percent terms) that respondents are willing to pay for non-biotech foods –are computed for biotech soybean oil and biotech rice based on mean values of the Z variables that reflect respondents' demographic and socio-economic variables, and their awareness of biotech foods. Mean values of WTP are estimated at 23.4 percent in the case of soybean oil and 41.5 percent in the case of biotech rice, excluding the "no" and "no" group in both the first and second bids with a randomly selected bid price of 80 percent.[2] Including this group would likely overstate true mean WTP because the upper end for true WTP is 100 percent rather than positive infinity specified in the CVM.[3] The *hypothetical* nature of the survey data, which would yield greater mean WTP than what is *revealed* in the market place, also suggests that the true value of WTP is lower than CVM results.

Urban respondents apparently had the perception that they would be willing to pay higher price premiums for non-biotech rice to avoid the consumption of biotech rice, if commercialized, because rice is a food grain. In contrast, soybean oil is a food product after crushing, which destroys much of the DNA sequence and thus even if biotech content is present in the product, the genetic material is not detectable using the lateral strip test.

Conclusions

This study reaffirms that Chinese consumers' awareness level of biotech foods has remained low in urban cities. Despite this low level of awareness, a great majority of China's urban consumers in eastern cities had favorable or neutral attitudes toward biotech foods. Only 5-15 percent of urban consumers were strongly or relatively opposed to biotech foods. This study suggests that if China's government would

[2]The magnitude of these mean WTPs is plausible based on our visit to a soybean crusher in Harbin, Heilongjiang Province in June 2005. This crusher currently processes identity-preserved non-biotech soybean oil and sells this product in Harbin supermarkets, but plans to expand the sales to Beijing, Shanghai, and other large cities at a price premium of 20% over vegetable oil made from imported biotech soybeans.

[3] Including this "no" and "no" group would inflate mean WTP to 52.6 percent for non-biotech soybean oil and 74.0 percent for non-biotech rice.

like to promote the acceptance of biotech foods, targeting the dissemination of information to consumers with the least exposure or awareness (less than three years familiarity) would be a more effective strategy to achieve the objective than a program across the board.

Results from the instrumental variable estimator suggest that the size of consumers' residing cities played a key role in affecting the acceptance of biotech foods. Mid- and small-city consumers are more supportive of the use of biotech foods than large-city consumers, with the impact being particularly pronounced for small-city consumers. Those consumers who trusted the accuracy of media information were also more willing to accept biotech foods.

This study suggests that consumers' positive attitudes toward biotech foods would pave the way for many food manufacturers and retailers to use less costly biotech ingredients and label products accordingly. The decision to label biotech products would, by and large, facilitate the export of China-approved biotech products (such as herbicide-tolerant soybeans) from the U.S. to China without incurring additional expenses in segregating biotech from non-biotech products.

Results of the WTP analysis suggest that the likely price premiums that respondents are willing to pay for non-biotech foods averaged around 23.4 percent for non-biotech soybean oil and 41.5 percent for non-biotech rice. The higher price premium for non-biotech rice suggests that opportunities may arise for Chinese food manufacturers and retailers to voluntarily label their rice products as non-biotech if the premium exceeds the higher cost of producing and marketing non-biotech rice.

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