Liquor and Beverage Consumption in China:

A Censored Demand System Approach

Cheng Fang

Asia Officer/Economist at Economic and Social Development, Food and Agriculture Organization of the United Nations

Suwen Pan

Research Assistant professor at department of Agricultural and Applied Economics, Texas Tech University, 79409

Paper prepared for presentation at the American Agricultural Economics Association Annual Meeting, Montreal, Canada, July 27-30, 2003

Introduction

Over the last two decades, Chinese consumers' preference for liquor and beverage consumption has changed significantly as per capita income has increased. Traditionally, Chinese people used to drink spirits and wine liquors. However, beer consumption increased rapidly in the 1980s and continued to grow in 1990s. Per capita beer consumption increased by 21 percent from 1990 to 1999, while per capita liquor consumption declined by 15 percent. Although the market for wine consumption is its initial shape, more and more people in the emerging middle and upper class drink more table wine. Per capita wine consumption increased by 89 percent from 1995 to 1999. The market potential for wine is huge considering the current low wine consumption at about 0.3 liter per year. In comparison, the world per capita average per year is 7 liters; in Japan, 4 liters; in the United States 7.4 liters, and in France , more than 59 liters.

After 15 years of negotiations, China finally joined the World Trade Organization (WTO) in December 2001. China's inclusion in the WTO has been a significant trade issue for the United States and the other large trading countries. China promised to eliminate tariffs on beer by 2005 from the current 70 percent, to cut tariffs on wine from current 65 percent to 14 percent by 2004, and to reduce tariff on barley from the current 16 percent to 9 percent by 2004.

In order to analyze China market potential for beer, wine, liquors and derived demand for barley and sorghum, the demand for these liquor and beverage need to be estimated. This study uses recent urban household-level survey data to estimate the demand for liquor and beverages by using a censored demand system approach.

Data and Estimation Procedures

The data

The data used are urban household surveys conducted by the National Statistical Bureau (NSB) of China in 1993 and 1998. The household survey was carried out by local agencies. The families selected in the surveys were drawn from a very large population frame in different years, based on proportionate stratification. This was a random sample. We used about 2298 household observations from Beijing, Taijin, Shanghai, and Jiangsu.

In the 2298 households, 96 percent at least bought liquor and beverage related products sometime in the survey periods. 51 percent drank wine, 43 percent drank beer, 14 percent drank juice, and 53 percent drank other related products. Detailed definitions and sample statistics for all variables are presented in Table 1.

Estimation Procedures

The households who consume the liquor and beverage provide best picture in our analysis purpose. However, the sample selection bias may occur when we discard the sample without liquor and beverage consumption. To solve the problem, an inverse-mills ratio is calculated based on whether the households consume or not, and the variable is used in the demand analysis in the earlier work. However, we did not find any of these variables is statistically significant in the equations. Therefore, it is dropped from the analysis.

The method used in the paper follows Shonkwiler and Yen (SY 1999), Su and Yen (UY 1999)'s consistent two-step estimation procedure for a system of censored equations. Following their approach, we model whether a household consumes wine, juice wine, beer, and others using latent variables with selection mechanism

$$
\begin{aligned}
y_{it} &= X_{it}'\beta_i + \varepsilon_{it} \quad \textit{if } d_{it} = Z_{it}'\alpha_i + v_{it} > 0 \\
&= 0 \qquad\qquad\qquad \textit{otherwise}
\end{aligned}
$$

$$(i=1,2,\ldots,n;\ t=1,2,..,T) \tag{1}$$

where , for the ith equation and tth observation, y_{it} is the dependent variable, X_{it} and Z_{it} are vectors of exogenous variables determining level and participation, respectively, α_i and β_i are comfortable parameter vectors, and ε_i and v_i are error terms.

The first step is a general probit mechanism, which includes four equations, whether consuming wine, juice wine, beer, and others in our analysis. Based on the step, a set of CDF $\phi(Z_{it}'\hat{\alpha}_i)$ and PDF $\Phi(Z_{it}'\hat{\alpha}_i)$ are calculated and used in the second step to estimate the different wine consumption.

For the second step, a standard Almost Ideal Demand Systems (LA/AIDS) is used in the estimation. The advantages of using LA/AIDS include: flexible functional form, satisfying exact aggregation across consumers, non-linear Engel curves, and a suitable linear approximation (Fabiosa and Jensen 2002). The form used in the second estimation is

$$W_{it} = \Phi(Z_{it}'\hat{\alpha}_i)\{\beta_{i0} + \sum_{j=1}^{n}\gamma_{ij}\ln p_{jt} + \beta_i \ln\left(\frac{Y_t}{P^*}\right) + \gamma_i D_{it}\} + \delta_i\phi(Z_{it}'\hat{\alpha}_i) + \xi_{it} \tag{2}$$

where W is the budget share of the different wine consumption in the total wine expenditure; Y is the predicted total wine expenditure; p is the nominal price of different wines; lnP^* is the stone index defined as $\ln P^* = \sum_k W_k \ln p_k$; D_{it} is a vector of demographic variables; ξ is stochastic error term distributed as iid (0,Ω); and (α,β,γ) is a vector of parameters.

Based on SY and UY, the standard error calculated by SUR or MLE based on the equation (2) are biased due to the heteroscedastic problem. To correct the bias, let log-likelihoods of the probit model be $L_{11}(\alpha_1)$, $L_{12}(\alpha_2)$, …, $L_{1n}(\alpha_n)$, the second-step model as $L_2(\hat{\alpha}_1, \hat{\alpha}_2, ..., \hat{\alpha}_n, \beta)$, the covariance matrix of $\hat{\beta}$ is

$$\Sigma = R_2^{-1} + R_2^{-1}[R_3^{/} R_1^{-1} R_3 - R_4^{/} R_1^{-1} R_3 - R_3^{/} R_1^{-1} R_4] R_2^{-1} \quad (3)$$

Where

$$R_1(\alpha) = diag[R_{11}(\alpha_1),....,....,..., R_{1n}(\alpha_n)] \quad (4)$$

$$R_2(\alpha) = diag[R_{21}(\beta_1),....,....,..., R_{2n}(\beta_n)] \quad (5)$$

$$R_3(\alpha, \beta) = [R_{31}^{/}(\alpha_1, \beta) \,|\, ... \,|\, R_{3n}^{/}(\alpha_n, \beta)] \quad (6)$$

$$R_4(\alpha, \beta) = [R_{41}^{/}(\alpha_1, \beta) \,|\, ... \,|\, R_{4n}^{/}(\alpha_n, \beta)] \quad (7)$$

and

$$\begin{aligned} R_{1i}(\alpha_i) &= -E\frac{\partial^2 L_{1i}}{\partial \alpha_i \partial \alpha_i^{/}}, R_2(\beta) = -E\frac{\partial^2 L_{1i}}{\partial \beta \partial \beta^{/}}, \\ R_{3i}(\alpha_i, \beta) &= -E\frac{\partial^2 L_2}{\partial \alpha_i \partial \beta'}, R_{4i}(\alpha_i, \beta) = -E\frac{\partial L_{1i}}{\partial \alpha_i}(\frac{\partial L_2}{\partial \beta})' \end{aligned} \quad (8)$$

As usual, we impose the theoretical restrictions of adding-up, homogeneity, and symmetry on the parameters as requested by LA/AIDS (Deaton and Muelbauer 1980). The expenditure and price elasticities are estimated using the following formula based on the model structure and the standard LA/AIDS formula given by Green and Alston (1990, 1991).

Because we only include expenditure in the consumption equation, the expenditure elasticity can be calculated as

$$\varepsilon_i = 1 + \frac{\Phi(Z_{it}' \alpha_i)\beta_i}{W_i} \quad (9)$$

The price elasticities are a little complicated because the effects of prices comes from both the participation and consumption equation. Let θ_{ij} be the Kronecker delta (θ_{ij}=1 for i=j; θ_{ij}=0 for i≠0), uncompensated own-price and cross-price elasticities can be derived as follows:

$$\varepsilon_{ij} = \frac{d \ln q_i}{d \ln p_j} = -\theta_{ij} + \frac{d \ln W_i}{d \ln p_j} = \Phi(Z'\alpha_i)\left(\frac{\gamma_{ij}}{W_i} - \frac{\beta_i W_j}{W_i} - \frac{\beta_i}{W_i}\sum_K W_K \ln p_k (\varepsilon_{kj} + \theta_{kj})\right)$$
$$-\delta_i (Z'_{it}\alpha_i)\phi(Z'_{it}\alpha_i)\alpha_{ij} - \theta_{ij} + \{\beta_{i0} + \sum_{j=1}^{n}\gamma_{ij} \ln p_{jt} + \beta_i \ln\left(\frac{Y_t}{P^*}\right) + \gamma_i D_{it}\} \quad (10)$$
$$* \phi(Z'_{it}\alpha_{it})\alpha_{ij}$$

To simplify the elasticity calculation, based on suggestion from Green and Alston (1990), the error from using the following formula is small:

$$\varepsilon_{ij} = \frac{d \ln q_i}{d \ln p_j} = -\theta_{ij} + \frac{d \ln W_i}{d \ln p_j} = \Phi(Z'\alpha_i)\left(\frac{\gamma_{ij}}{W_i} - \frac{\beta_i W_j}{W_i}\right) - \delta_i (Z'_{it}\alpha_i)\phi(Z'_{it}\alpha_i)\alpha_{ij}$$
$$-\theta_{ij} + \{\beta_{i0} + \sum_{j=1}^{n}\gamma_{ij} \ln p_{jt} + \beta_i \ln\left(\frac{Y_t}{P^*}\right) + \gamma_i D_{it}\} * \phi(Z'_{it}\alpha_{it})\alpha_{ij} \qquad (11)$$

Because total liquor and beverage consumption expenditure and share of different wines are highly correlated, it is possible that the covariance of independent variable and the residuals of the demand equation is non-zero, a condition that would bias parameter estimates of the impact of wine expenditures on the different types of wine demand. In other words, wine expenditure maybe endogenous to wine demand equation system. To avoid this possible econometric problem, an Instrumental Variable (IV) approach is adopted and the predicted wine expenditures based on whether a household consumes wine or not is used in equation (2).

Results

ML probit estimates for wine, juice, beer and others are presented in Table 2. At the 10 percent level of significance, our results suggest that consumption of beer, wine, juices and other beverages in China is responsive to income and price changes. As income increase, the probabilities of wine, juice, beer and other related products consumption increase. The probabilities of four types of consumption decrease as their own price increase. One interesting results here is that the probability of juice consumption increase as the price of beer increase, the probability of beer increase as wine price increase, which imply there is substitution between beer and juice, as well as between wine and beer.

In addition to responses to changes in prices and income, demographic variables also affect the probabilities of different wine type consumption. A household head who is male is more likely to drink wine and beer than those with female household head; those with higher education are more likely to drink wine, beer but less juice than those with less education, partly because they have a more secure job and more social life than those with less education. The positive effects of employment also show that those with a full time or part time job are more likely to consume beer than those not. Those residing in north are more likely to drink wine, and beer than those in south. But the southern people are more interested in juice consumption.

Table 3 presents ML results for the system of equations, including parameter estimates, corrected standard errors. The explanation of the coefficient is complicated due to the model structure. The problem can be solved by calculating the elasticities. Table 4 provides the income and price elasticities calculated based on equation (9) and (11). Juice and beer demand had total expenditure elasticities less than one (necessities). The expenditure elasticity for wine is larger than one (luxury). The price elasticities for wine and juice are larger than that for beer. Both wine and juice are elastic in marshallian elasticity. However, only juice is elastic in Hicksian elasticity.

The results show that beer has been the most popular alcoholic related drink in China. Beer and juice are the normal goods in the country but wine is still a luxury good. The important implication is that the demand for wheat will increase slowly due to the stable consumption of beer in China. However, wine consumption will increase sharply as per capita income increases.

Concluding Remarks

This paper estimated the Liquor and Beverage Consumption based on a Chinese survey data. The results showed that beer consumption has been relatively stable during the past 10 years. However, there exists large potential wine market in china. The results have significantly trade implications as China's income growth, urbanization, and tariff reduction committed in the WTO agreement.

Reference

Fabiosa, Jacinto and Jensen, H. Helen. "Microeconomic Adjustments of Households to Macroeconomic Shocks: Household Level Welfare Impacts of the Indonesian Economic Crisis." Paper presented in American Agricultural Economics Annual Meeting in Long Beach, California, July 28-31, 2002.

Green, Richard and Alston, Julian M. "Elasticities in AIDS Models." Amer. J. Agr. Econ. 72(Nov., 1990): 442-445.

Su, Shew-jiuan B. and Yen, Steven T. " A Censored System of Cigarette and Alcohol Consumption," Applied Economics 332 (2000): 729-737.

Shonkwiler J. Scott and Yen, Steven T. " Two-Step Estimation of A Censored System of Equations," Amer. J. Agr. Econ. 81(Nov., 1999): 972-982.

Table 1 Definition and Sample Statistics (*n=2298*)

Variables	Definiftion	Mean	Std Dev
WEXP	Liquor and Beverage Expenditure per capita	111.21	117.32
WSHARE	Wine share in the total expenditure	0.31	0.33
JSHARE	Juice share in the total expenditure	0.06	0.16
BSHARE	Beer share in the total expenditure	0.39	0.31
OSHARE	Other wine share in the total expenditure	0.20	0.29
WPRICE	Wine price	12.93	12.52
JPRICE	Juice price	10.18	4.63
BPRICE	Beer price	2.55	1.05
OPRICE	Other related price	4.87	4.24
INCOME	Income per capita(yuan)	5585.26	3838.93
EDUCATION	Years of formal education for the household head	9.81	2.65
AGE	Age in years for the household head	50.17	12.46
Dummy variables (yes=1, no=0)			
NORTH	Resides in North	0.48	
CITY	Resides in Beijing, Tianjin, Shanghai	0.91	
YDUM	Year in 1998	0.50	
MALE	Male household head	0.59	
EMPLOY	Household head is employed half or full time	0.75	

Source: Calculated by Authors.

Table 2 Univariate Probit Regression Explaining Consumption Porbabilities for wine, Juice, Beer and others

	Wine		Juice		Beer		Others	
	Coef	Std error	Estimate	Error	Estimate	Error	Estimate	Error
Intercept	-1.0849*	0.2501	2.3284*	0.3183	0.419	0.3083	-0.0486	0.2908
wprice	-0.0076*	0.003	0.0004	0.003	0.0057*	0.0033	0.006*	0.0029
jprice	-0.0046	0.0063	-0.0688*	0.0078	0.0121*	0.0073	-0.0007	0.0072
bprice	0.0448	0.034	0.0735*	0.0372	-0.1161*	0.0422	-0.0687*	0.0407
oprice	-0.0113*	0.0062	-0.0085	0.0073	-0.034*	0.0107	-0.0265*	0.0115
Income	0.0203*	0.0112	0.0378*	0.0137	0.0711*	0.0134	0.0755*	0.013
male	0.2932*	0.0589	0.0087	0.077	0.2123*	0.0726	0.2737*	0.0683
north	0.6518*	0.059	-0.1554*	0.0774	2.1648*	0.0756	1.8038*	0.0676
edu	0.0645*	0.0111	-0.0211*	0.0103	0.0253*	0.0136	0.0125	0.0128
age	0.0155**	0.0031	-0.0029	0.0039	-0.0173*	0.0038	-0.0151*	0.0036
employ	0.0933	0.0868	-0.0241	0.1125	0.1723*	0.1058	0.1898*	0.1024
ydum	-0.0713	0.0905	0.1816	0.1198	0.7028*	0.1124	0.5518*	0.1054
Log-likelihood	-1379.64		-731.61		-842.85		-979.76	

*Indicate significant at 10% level.

Table 3 ML Estimation of System of Equations for Wine, Juice, Beer
(Dependent variables: Wshare, Jshare, Bshare)

	WINE		JUICE		BEER	
	Coeff	Std Error	Coeff	Std Error	Coeff	Std Error
$\Phi(Z,\alpha)$	-4.976***	0.464	0.156***	0.068	0.256***	0.191
North*$\Phi(Z,\alpha)$	-1.023***	0.102	-0.036***	0.009	0.665	0.115
YDUM*$\Phi(Z,\alpha)$	-0.036	0.031	0.011	0.011	-0.029	0.032
Age*$\Phi(Z,\alpha)$	0.023***	0.002	-0.0004	0.00046	-0.002	0.0013
EDU*$\Phi(Z,\alpha)$	0.108***	0.010	-0.003	0.0016	-0.002	0.004
EMPLOY*$\Phi(Z,\alpha)$	0.162***	0.034	-0.009	0.012	-0.051	0.035
MALE*$\Phi(Z,\alpha)$	-0.452***	0.045	-0.007	0.0084	0.057***	0.023
WPRICE*$\Phi(Z,\alpha)$	-0.144***	0.024	-0.003	0.0099	0.0082	0.022
JPRICE*$\Phi(Z,\alpha)$	-0.155***	0.032	-0.054***	0.012	-0.048	0.030
BPRICE*$\Phi(Z,\alpha)$	0.324***	0.038	0.086***	0.014	-0.030	0.027
log(WEXP/SPI)* $\Phi(Z,\alpha)$	0.267***	0.049	-0.036***	0.014	-0.112***	0.049
$\phi(Z\alpha)$	4.130***	0.238	1.134	0.044	1.312***	0.105
Log-likelihood			702.499			

Table 3 Expenditure elasticity

	Elasticity	Average Share
Wine	1.394	0.31
Juice	0.51	0.06
Beer	0.85	0.39
Others	0.74	0.20

Table 4 Marshallian elasticity

	wine	juice	beer	others
wine	-1.362	-0.371	0.490	-0.414
juice	-1.410	-1.891	1.651	1.084
beer	0.776	0.178	-0.901	-0.831
others	-0.178	0.508	-1.452	0.579

Table 5 Hicksian elasticity of the different prices

	wine	juice	beer	Others
wine	-0.829	-0.261	1.158	-0.067
juice	-1.228	-1.853	1.879	1.203
beer	1.028	0.229	-0.590	-0.667
others	-0.003	0.544	-1.233	0.692