CONSUMPTION OF TOBACCO AND ALCOHOLIC BEVERAGES AMONG SPANISH CONSUMERS

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ABSTRACT

The joint selection and purchase of alcohol and tobacco in Spain is modeled using bivariate probit and endogenous switching regression analysis to account for the interaction between drinking and smoking. Different expenditure structures for tobacco and alcohol arise when one or both are consumed. Endogenous switching among structures exists because households are not randomly assigned. The results show that the correlation term of the selection equations and most correction terms for self-selectivity bias are statistically significant. The results also show that income and household demographic variables are important determinants of both selection and expenditures on tobacco and alcohol.

INTRODUCTION

Researchers from different fields have shown a long-standing interest in studies related to the consumption of alcohol and tobacco for two reasons. First, because of the social and health related problems associated with the abusive consumption of these commodities, and second, because of the need to evaluate the impact of different tax schemes on these goods in promoting government revenues, improving general welfare and controlling consumption. For instance, the Spanish government recently increased the tax rates on tobacco and alcoholic beverages once more, and is expecting increased revenues and reduction in consumption of these products. From this perspective, it is no wonder that the consumption of alcohol and the consumption of tobacco are often considered as two related matters by policy-makers, health officials and social scientists. In fact, there is strong empirical evidence that smoking and drinking are not independent activities (Jones [18]; Goel and Morey [10]; Jones and Mazzi [21]; Moore [29]; Su and Yen [33]).

For over ten years, researchers have estimated the demands for tobacco and alcoholic beverages by using the double hurdle approach. This modeling approach allows differentiation between abstentions and corner solutions (those consumers who decide not to consume for certain levels of prices and income). The applications include, among others, Jones [17, 18, 19], Heien and Pompelli [13], Blaylock and Blisard [3, 4, 5], Fry and Pashardes [8], Garcia and Labeaga [9], Yen and Jensen [34], and Su and Yen [33]. However, standard double hurdle models do not allow for potential correlation between the decisions to smoke and drink.

Only a few studies have accounted for the interaction between drinking and smoking. Blaylock and Blisard [3, 4, 5] used a double hurdle approach to study the socio-economic factors affecting the participation and expenditure decisions on alcohol and tobacco independently. They implicitly recognized the interaction between the consumption of alcohol and tobacco by including a dummy variable (indicating whether or not the individual smokes) in the participation equations for alcohol and wine. Jones [18], Goel and Morey [10], and Jones and Mazzi [21] studied the interactions between the consumption of tobacco and alcohol using a demand systems approach to estimate budget share equations for different categories of alcoholic beverages and tobacco. Moore [29] also presented evidence of the complementarities between alcohol and tobacco consumption in his study of the effects of alcohol and tobacco taxes on mortality for the US. Lately, Su and Yen [33] have studied the US consumption of cigarette, beer and wine as a two-step decision process using a consistent two-step estimation procedure for a system of censored equations.

All these previous studies ignored the fact that a typical sample of households includes: households that consume both tobacco and alcoholic beverages, households that only consume alcoholic beverages, households that only consume tobacco, and households that consume neither tobacco nor alcoholic beverages. Currently available studies on tobacco and alcohol demand generally ignore the importance of these sub-samples. Given that these sub-samples are not entirely random draws from the population, a more complete model of tobacco and alcohol demand should take into account the joint determination of whether or not to consume tobacco and/or alcoholic beverages. And conditional on that decision, how much to spend on the purchase of tobacco and/or alcoholic beverages, should follow. Additional insights can be gained and more efficient parameter estimates obtained if we consider explicitly the potential correlation between the disturbance terms of the participation equations as well as the potential correlation between the disturbance terms of the participation and expenditure equations. Jones [18], and Fry and Pashardes [8] have pointed out the importance of distinguishing between "smokers" and "non-smokers" and "drinkers" and "non-drinkers" because they have different demand patterns or regimes.

Miles [28] questioned the use of the double hurdle models for the estimation of tobacco demand in Spain. He argued that one of the underlying assumptions of these models (a relatively large number of corner solutions or "zero-smokers") was not supported by the data. He used the *Encuesta de Presupuestos Familiares* 1990-91 (Spanish Expenditure Survey 1990-91), and found that the proportion of "smoker" households reporting zero expenditures on tobacco was extremely small and that almost all zeros were from "non-smokers".[1] Although it is true that zero expenditures on tobacco could also be due to infrequency of purchases, Lopez [25] found that this was a minor problem in the case of tobacco for Spain. Keen [24] and Blundell and Pashardes [6] also considered models where the zero expenditure on alcoholic beverages corresponded to purchase infrequency rather than corner solutions. We follow this approach based on adjusted data from Pena and Ruiz-Castillo [31]. Pena and Ruiz-Castillo [31] used a Poisson model for frequency of bulk purchases to adjust the reported food expenditures (including tobacco and alcoholic beverages) and data from the Encuesta de Presupuestos Familiares 1990-91 to estimate the frequency of bulk purchases (Arevalo *et al.,* [2]). Pena and Ruiz-Castillo's "adjusted for bulk purchase" expenditures on tobacco and alcohol can be used to distinguish among these regimes because the remaining zeros could be considered as belonging to "non-smokers" and "non-drinkers".

All the above findings have important implications for modeling tobacco and alcohol demands in Spain. The joint decision processes are likely to be significant and the modeling should allow for the potential interaction between drinking and smoking. The analysis of expenditures on tobacco and alcohol should also allow for potential different demand regimes for (1) "smokers" and "drinkers", (2) "drinkers" and "non-smokers", (3) "smokers" and "non-drinkers", and (4) non-drinkers" and "non-smokers". By modeling the four separate regimes, we allow the socioeconomic factors to have different effects on consumption for the four groups. In this research, we consider explicitly the potential correlation between the disturbance terms of the decision to purchase equations as well as the potential correlation between the disturbance terms of the decision to purchase and the expenditure equations. Specifically, we use Bivariate Probit Analysis and Endogenous Switching Regression techniques to model the interaction between the choice to consume tobacco and/or alcoholic beverages, and the expenditure on both tobacco and alcoholic beverages. In general, we find that, indeed, decisions to purchase tobacco and alcoholic beverages are related, and should be modeled as joint consumption decisions. We also find that determinants of size of expenditure on tobacco and alcoholic beverages affect these two consumption decisions differently. We present details of our findings in the Results and Discussion section; but first, the following section lays out the theoretical framework and empirical specifications of our analysis.

THEORETICAL MODEL AND EMPIRICAL SPECIFICATION

It is assumed that rational households seek to maximize their satisfaction given their different preferences and budget constraints. To achieve this, they first choose to consume one of the following: both alcohol and tobacco; alcohol only; tobacco only; or neither of them. In a second step, and conditional on these decisions, the households decide the level of expenditures on these commodities.

In economic terms, the resulting combinations are the source of multiple economic structures for the demand functions of these goods – i.e., a household's behavior is different when it consumes both tobacco and alcoholic beverages compared to when it only consumes tobacco or alcoholic beverages. In other words, there will exist different structures of household demand functions for these commodities when: (1) both tobacco and alcohol are consumed; (2) only alcohol is consumed; (3) only tobacco is consumed; and (4) neither of them is consumed.

Seeing that decisions on belonging to one regime or the other are based on households' optimizing behavior, households choose to belong to one regime or another. Under these conditions, there is endogenous switching between regimes because households are not randomly assigned to individual regimes (Maddala and Nelson [27]; Maddala [26]; Huffman [15]).

Formally, every household is assumed to maximize its utility function

$$U(q; d) \tag{1}$$

subject to the linear budget constraint

$$p'q = m \tag{2}$$

where U refers to the household utility function; $q = (q_1, q_2,..., q_n)$ is a nx1 vector of quantities of goods 1,..., n; $d = (d_1, d_2,...,d_s)$ is a sx1 vector of household characteristics; $p = (p_1, p_2,..., p_n)$ is a nx1 vector of prices of goods 1,...,n; and m is the fixed amount of money available to the consumer.

Assuming the usual neoclassical properties of utility functions, the solution to this problem gives the n optimal values of q_i as

$$q_i = q_i\,(p_1,...,p_n, d_1, d_2,...,d_s, m) \qquad i = 1,...,n \tag{3}$$

which are the so called ordinary (Marshallian) demand functions. The relationship (using cross-section data)

$$e_i = g_i\,(d_1, d_2,...,d_s, m) \qquad i = 1,...,n \tag{4}$$

is referred to as the Engel function, where e_i represents the household expenditures on good i. They are demand functions that express the expenditure on commodities as a function of income only, assuming all prices to be constant.

The different regimes are represented by equations (5) – (8) below.

Regime 1 (household consumes both tobacco and alcoholic beverages):

$$\text{if } w_a^* = \delta_a' z_a + \zeta_a > 0 \quad \text{and} \quad w_t^* = \delta_t' z_t + \zeta_t > 0 \tag{5}$$

Regime 2 (household consumes alcoholic beverages only):

$$\text{if } w_a^* = \delta_a' z_a + \zeta_a > 0 \quad \text{and} \quad w_t^* = \delta_t' z_t + \zeta_t \leq 0 \tag{6}$$

Regime 3 (household consumes tobacco only):

$$\text{if } w_a^* = \delta_a' z_a + \zeta_a \leq 0 \quad \text{and} \quad w_t^* = \delta_t' z_t + \zeta_t > 0 \tag{7}$$

Regime 4 (household consumes neither alcoholic beverages nor tobacco):

$$\text{if } w_a^* = \delta_a' z_a + \zeta_a \leq 0 \quad \text{and} \quad w_t^* = \delta_t' z_t + \zeta_t \leq 0 \tag{8}$$

where z_a and z_t are vectors of explanatory variables; δ_a and δ_t are parameter vectors; and ζ_a and ζ_t are disturbance terms. Notice that w_a^* and w_t^* are latent unobservable variables representing the household's desire to consume tobacco and alcoholic beverages.

However, we can observe two dummy variables w_a and w_t such that $w_a = 1$ if $w_a^* > 0$ and $w_a = 0$ otherwise, and $w_t = 1$ if $w_t^* > 0$ and $w_t = 0$ otherwise.

The conditional Engel equations express the fact that the structure of demand for these two commodities is different when only one or the two are consumed (See Appendix A). If there is endogenous switching among regimes, then households have a nonzero probability of being assigned to each regime (see Appendix B).

If the ζ's are correlated with each other and correlated with the disturbance terms in the conditional Engel equations (i.e., equations (A1) – (A4) in Appendix A), the disturbance terms of the conditional expenditure equations have nonzero mean values and the sample selection process is not random. That is, there exists selectivity bias. If this set of equations were to be fitted directly to the observations in each of the sub-samples by least squares, the estimated coefficients would be biased (Maddala [26]; Heckman [12]). Thus, correction for the nonzero conditional mean value of the disturbance terms (μ's) in the conditional Engel equations is required.

We used a two-step procedure to correct for nonzero mean disturbance terms. First, bivariate probit analysis was used to get estimates of δ_a and δ_t. Second, these bivariate probit estimates were used to compute probabilities of being assigned to each regime (i.e., (B1) – (B3) in Appendix B). Third, these probabilities were used to compute the correction terms (Amemiya [1]; Huffman and Lange [16]). Finally, correction for self-selectivity bias was done adding the correction terms and a new disturbance term (which has a zero conditional mean) to each expenditure equation for all regimes.

Therefore, the Engel equations corrected for selectivity bias are as follows:

For Regime 1 (consumption of alcohol>0 and consumption of tobacco>0):

$$e_a = \beta_1' x_{a1} + \gamma_{aa1} (S_{a1} / M_{11}) + \gamma_{at1} (S_{t1} / M_{11}) + \varepsilon_{a1}$$

$$e_t = \beta_2' x_{t1} + \gamma_{ta1} (S_{a1} / M_{11}) + \gamma_{tt1} (S_{t1} / M_{11}) + \varepsilon_{t1} \qquad (9)$$

For Regime 2 (consumption of alcohol>0 and consumption of tobacco=0):

$$e_a = \beta_3' x_{a2} + \gamma_{aa2} (S_{a2} / M_{10}) + \gamma_{t2} (S_{t2} / M_{10}) + \varepsilon_{a2}$$

$$e_t = 0 \qquad (10)$$

For Regime 3 (consumption of alcohol=0 and consumption of tobacco>0):

$$e_a = 0$$

$$e_t = \beta_4' x_{t3} + \gamma_{ta3} (S_{a3} / M_{01}) + \gamma_{tt3} (S_{t3} / M_{01}) + \varepsilon_{t3} \qquad (11)$$

where e_a and e_t represent expenditures on alcoholic beverages and tobacco; x_{a1}, x_{t1}, x_{a2} and x_{t3} are vectors of explanatory variables; β_1, β_2 , β_3 and β_4 are unknown parameter vectors; $\gamma_{aa1}, \gamma_{at1}, \gamma_{ta1}, \gamma_{tt1}, \gamma_{aa2}, \gamma_{at2}, \gamma_{ta3}$ and γ_{tt3} are unknown parameters; M_{11}, M_{10} and M_{01} are defined in equations (B1) – (B3) in Appendix B; S_{a1}, S_{t1}, S_{a2}, S_{t2}, S_{a3} and S_{t3} are defined as in Amemiya [1] and Huffman and Lange [16]; and $\varepsilon_{a1}, \varepsilon_{t1}, \varepsilon_{a2}$ and ε_{t3} are the new zero mean disturbance terms. Equations (9) – (11) are the equations to be estimated.

DATA

The government of Spain periodically conducts household surveys (*Encuestas de Presupuestos Familiares*) in order to collect data related to expenditures, income, savings and socioeconomic characteristics of Spanish households. These surveys gather data on income from different sources, expenditures, number of hours worked, occupation, education, and so on for the household head, the spouse and other household members.

Table 1
Names and description of dependent and independent variables

Variable Names	**Description**
Dependent Variables:	
consalc	Binary variable: consume alcohol (yes =1, no =0)
constob	Binary variable: consume tobacco (yes =1, no =0)
alcohol	Yearly alcohol consumption (mill. of pesetas)
tobacco	Yearly tobacco consumption (mill. of pesetas)
Continuous Independent Variables:	
nper	Number of income earners in the household
young	Number of household members aged 18-24
adult	Number of household members aged 25-64
elderly	Number of household members aged 65 and older
income	Household income (10,000,000 pesetas/year)
headage	Head of household's age
hhsize	Household size
Dummy independent variables (yes = 1, no = 0):	
educ	household head has at least a high school education
employed	household head is employed
homepay	household is a homeowner
south	household resides in the south
norteast	household resides in the northeast and east
nortwest	household resides in the northwest
central	household resides in the central region[a]
urban	household resides in central city or suburban area
headsex	household head is male

[a] Households that reside outside the Iberian Peninsula were not included in the regional location category.

We used Pena and Ruiz-Castillo's "adjusted for bulk purchase" expenditures on tobacco and alcoholic beverages (Arevalo *et al.,* [2]) and the latest *Encuesta de Presupuestos Familiares* (conducted between April of 1990 and March of 1991) as the basis for this research. This survey contains data for 21,155 Spanish households. All 21,155 households were divided in 4 subsamples or regimes. A total of 11,298 (53.4%) reported expenditures on both alcohol and tobacco; 2,812 (13.3%) reported expenditures on alcohol only; 3,238 (15.3%) reported expenditures on tobacco only; and 3,807 (18.0%) reported no expenditures on either alcohol or tobacco. Out of the 21,155 households, 14,026 (66.3%) consumed alcohol and 14,533 (68.7%) consumed tobacco.

Table 2
Sample means and standard deviations (in parentheses)

Variable	Regime 1	Regime 2	Regime 3
<u>Dependent Variables:</u>			
consalc	1.000	1.000	-
constob	1.000	-	1.000
alcohol	.032	.037	
	(.057)	(.059)	
tobacco	.049		.053
	(.050)		(.058)
<u>Continuous Independent Variables:</u>			
nper	1.996	1.662	1.888
	(1.000)	(.788)	(.924)
young	.525	.220	.475
	(.818)	(.538)	(.759)
adult	1.927	1.334	1.814
	(.841)	(.969)	(.849)
elderly	.370	.714	.351
	(.669)	(.838)	(.661)
income	.287	.210	.232
	(.174)	(.143)	(.147)
headage	49.610	57.800	49.150
	(14.20)	(15.28)	(14.89)
hhsize	3.846	2.907	3.635
	(1.520)	(1.420)	(1.487)
<u>Dummy independent variables (yes = 1, no = 0):</u>			
educ	.225	.154	.180
	(.417)	(.361)	(.385)
employed	.678	.464	.650
	(.467)	(.499)	(.477)
homepay	.857	.893	.827
	(.350)	(.309)	(.379)
south	.229	.162	.171
	(.420)	(.369)	(.377)
norteast	.296	.327	. 319
	(.457)	(.469)	(.466)
nortwest	.121	.153	.107
	(.326)	(.360)	(.309)
central	.273	.314	.348
	(.445)	(.464)	(.476)
urban	.572	.457	.464
	(.495)	(.498)	(.499)
headsex	.887	.825	.864
	(.317)	(.380)	(.343)

Definitions of the dependent and independent variables included in the models are presented in Table 1. Table 2 contains the sample statistics for the continuous and binary variables for the different regimes.

RESULTS AND DISCUSSION

The parameter estimates obtained from the bivariate probit analysis were used to construct estimates of the correction terms for self-selectivity bias and to learn about the socio-economic factors that affect the decision to purchase tobacco and alcohol (see Table 3). The estimated correlation coefficient of the disturbance terms of the participation equations turned out to be positive and statistically different from zero (the *t*-test is equivalent to the Wald test). This implies that the two equations are not statistically independent and that the two disturbance terms are affected similarly by random shocks, thus, the decisions to smoke and drink are related. The statistically significant correlation provides evidence to support the hypothesis of interdependencies between the decisions to consume these two potentially addictive commodities.

In general, the analysis showed that most socio-economic variables were statistically significant at α=.05 (26 out of 33) and this suggests that these variables are important in determining the joint selection decision for tobacco and alcohol.

The results of the bivariate probit analysis also indicated that households with male heads and households located in urban areas are more likely to consume both alcohol and tobacco. Higher income levels and more members 18 and older significantly increase the odds of consuming these products. On the other hand, the presence of older household heads decreases the likelihood of consuming both alcohol and tobacco. Further, households located in the northeastern, northwestern and central parts of the peninsula are less likely to consume these two commodities relative to households located outside the peninsula.

Results also showed that homeowners and households with employed main heads are less likely to consume tobacco. On the contrary, households with more members receiving income are more likely to consume it.

A Lagrange Multiplier test for contemporaneous correlation between the disturbance terms (Greene [11]) of the tobacco and alcohol Engel equations for regime 1 was performed. We rejected the null hypothesis (all covariances were zero) and concluded that contemporaneous correlation did exist. Thus, we used Seemingly Unrelated Equation (SURE) techniques to fit the Engel equations for regime 1, with sample selection terms included because of the existence of contemporaneous correlation between ε_{a1} and ε_{t1}. It is quite likely that some unmeasurable characteristics of a given household or the effects of taxation, health and public policies or the general state of the economy could have similar effects on the disturbances of the demands for tobacco and alcoholic beverages. SURE estimation also allowed us to deal with heteroscedastic disturbance terms. The assumptions of the SURE model already allow for heteroscedasticity across cross-sectional units (Judge *et al.,* [22]). The expenditure equation for alcohol from regime 2 and the expenditure equation for tobacco from regime 3 were fit by ordinary least squares (OLS).

Table 3
Bivariate probit explanation of participation in tobacco and alcohol consumption

Variables	Participation alcohol	Participation tobacco
constant	-.206**	.626**
	(-2.82)	(7.74)
nper	.014	.056**
	(1.01)	(3.76)
educ	-.019	-.030
	(-0.72)	(-1.08)
employed	.010	-.106**
	(0.37)	(-3.61)
homepay	.047*	-.165**
	(1.70)	(-5.41)
young	.066**	.295**
	(4.31)	(17.63)
adult	.200**	.402**
	(12.38)	(21.78)
elderly	.199**	.250**
	(8.98)	(11.09)
south	-.016	-.055
	(-0.37)	(-1.20)
norteast	-.287**	-.352**
	(-6.97)	(-8.06)
nortwest	-.111**	-.330**
	(-2.42)	(-6.76)
central	-.340**	-.312**
	(-8.29)	(-7.10)
urban	.177**	.158**
	(9.13)	(7.65)
headsex	.357**	.289**
	(13.10)	(9.75)
income	1.337**	.904**
	(22.13)	(13.38)
headage	-.066**	-.216**
	(-7.19)	(-21.54)
rho (correlation coefficient)		.417**
		(37.19)
- Log-Likelihood		22330.45

* and ** denote statistical significance at 10 and 5% respectively. Asymptotic *t*-values are in parenthesis.

Table 4 presents the unadjusted parameter estimates obtained from the SURE and OLS estimation for all three regimes. All *F*-ratios were larger than the 95 percent critical value of 1.88; thus, we concluded that the data are inconsistent with the hypothesis that all slopes in the expenditure equations are zero. We also measured the interrelationships among the independent variables and conclude that multicollinearity is not a serious problem in this study.

Most of the parameter estimates were statistically significant for regime 1 (24 out of 38) and regime 3 (10 out of 18) at the 5% significance level. Fewer parameter estimates were significant for regime 2 (8 out of 18). Most of the parameter estimates of the correction terms were statistically significant: 5 out of 8 were statistically significant at $\alpha = .05$ (6 of them were at $\alpha = .10$) confirming that the correction for selectivity bias was,

Table 4
Conditional parameter estimates for the expenditure equations

Variables	Regime 1		Regime 2	Regime 3
	Alcohol	tobacco	alcohol	tobacco
Intercept	.017**	.047**	.102**	.054**
	(3.09)	(10.06)	(3.02)	(6.77)
nper	.001	.004**	.005**	.002
	(0.96)	(6.00)	(2.47)	(1.20)
educ	-.005**	-.006**	-.001	-.010**
	(-3.44)	(-5.19)	(-0.08)	(-3.58)
employed	-.001	-.007**	-.001	-.006**
	(-0.33)	(-5.75)	(-0.16)	(-2.22)
homepay	-.007**	-.014**	-.012**	-.010**
	(-4.26)	(-10.56)	(-2.25)	(-3.70)
young	-.001	.011**	.006	.011**
	(-1.30)	(14.64)	(1.33)	(6.32)
adult	-.001	.008**	.005	.010**
	(-0.07)	(8.40)	(1.58)	(4.64)
elderly	.002	.003**	-.001	.004
	(1.59)	(2.56)	(-0.02)	(1.37)
south	.006**	.007**	-.006	.002
	(2.94)	(3.66)	(-0.93)	(0.40)
norteast	.005**	.001	-.005	-.007
	(2.26)	(0.81)	(-0.85)	(-1.61)
nortwest	.011**	-.002	.007	-.010*
	(4.54)	(-1.24)	(1.17)	(-1.93)
central	-.001	.002	-.002	-.006
	(-0.47)	(1.15)	(-0.27)	(-1.24)
urban	-.008**	.002**	-.017**	.003
	(-6.79)	(2.05)	(-5.56)	(1.31)
headsex	.005**	-.001	-.004	.005
	(2.35)	(-0.41)	(-0.63)	(1.53)
income	.068**	.045**	.035**	.101**
	(16.70)	(13.29)	(1.98)	(11.25)
headage	.000	-.005**	-.004**	-.009**
	(0.15)	(-9.74)	(-2.06)	(-7.44)
hhsize	-.001	.001**	-.003**	-.001
	(-1.23)	(2.22)	(-2.03)	(-1.31)
γ_{1a}	.023	.130**		
	(0.63)	(4.27)		
γ_{1t}	-.027	-.121**		
	(-0.72)	(-3.94)		
γ_{2a}			.007*	
			(1.78)	
γ_{2t}			-.060**	
			(-2.31)	
γ_{3a}				.036**
				(6.67)
γ_{3t}				.026**
				(4.14)
Adj R-sq	0.0477	0.1562	0.0569	0.0812
Root MSE	0.0560	0.0462	0.0575	0.0555
F[19, 11278]	29.61			
F[19, 11278]		110.90		
F[19, 2812]			10.42	
F[19, 3238]				16.90

* and ** denote statistical significance at 10% and 5%, respectively. Asymptotic *t*-values are in parentheses.

indeed, necessary.

In general, the effects of income and other socioeconomic variables on alcohol and tobacco expenditures are consistent with findings from previous research in terms of statistical significance, and the direction and size of these effects.

Income has a positive influence on the consumption of alcohol and tobacco. The conditional income elasticities for both tobacco and alcohol were computed using the parameter estimates of the SURE and OLS regressions (evaluated at the sample means). These elasticities measure how income affects the level of expenditures on tobacco and alcohol conditional on consumption (i.e., given that a decision is made to consume).

The income elasticities for alcohol were 0.61 (regime 1) and 0.20 (regime 2). For tobacco they were 0.26 (regime 1) and 0.44 (regime 3). Note, that all of the income elasticities are positive but less than 1, indicating that they are normal goods but income inelastic. These estimated elasticities were in agreement with findings from previous research using cross-section data for the US and the UK (Jones [17]; Heien and Pompelli [13]; Blaylock and Blisard [4]; Goel and Morey [10]; Yen and Jensen [34]; Su and Yen [33]). These relatively low income elasticities suggest that demand for tobacco and alcohol in Spain will not change much with respect to expected changes in households' incomes likely to accrue from the EU economic integration. Also, knowledge of these income elasticities can help policy-makers and industry planners to promote appropriate long-run changes in the industry. For instance, they could be useful to estimate the effects of income tax changes on the pattern of tobacco and alcohol demand.

Tobacco and alcohol consumption decreases with age. Older family heads may be more health conscious about the adverse health effects related to the consumption of these goods and have a less stressful lifestyle. These results may also reflect the effects of policies targeted to discourage adult smoking and drinking in Spain (higher insurance premiums, workplaces and restaurants with smoking bans, tougher laws against drunk driving, etc) and the effects of new risk information. Hsieh [12] found evidence to support the argument that smokers learn (with age) new risk information and this creates an incentive to quit smoking from their own experience. The negative effects of age also suggest that programs designed to reduce tobacco and alcohol purchases and consumption should target younger households. Nayga [30], Garcia and Labeaga [9], Kabat and Wynder [23], Hsieh [14], and Su and Yen [33] also found a statistically significant negative effect of age on tobacco and alcohol consumption for the US and Taiwan.

The number of income recipient members in the household had a positive effect on tobacco expenditures (regime 1) and alcohol expenditures (regime 2). Garcia and Labeaga [9], and Fry and Pashardes [8] also found a significant positive effect of number of income recipients on tobacco expenditures for Spain and the UK. Household size had a positive impact on tobacco expenditures (regime 1) but a negative impact on alcohol expenditures (regime 2). Heien and Pompelli [13], and Nayga [30] also found a negative effect of household size on tobacco consumption for the US.

Tobacco expenditures increased with more family members 18-64 (for regime 1, they also increased with more family members 65 and older). These results suggest that household composition is an important determinant of alcohol and tobacco consumption. They may also reflect the influence of social interaction on smokers' behavior. Two or more smokers in a household will tend to "support" each other's habit and make quitting harder when there is close proximity to other smokers (Jones [17]). Jones [17], Fry and

Pashardes [8], and Garcia and Labeaga [9] also found similar results for the UK and Spain.

Homeowners tend to spend less on tobacco and alcohol than do renters. These results are in agreement with previous findings by Jones [17] for the UK. He suggests that this result might reflect the influence of the stress of the living environment on the dependence of the psychological support provided by smoking and drinking. It might also reflect differences in time preference across different wealth or social groups.

More educated households spend less on tobacco than do less educated households (for regime 1, expenditures on alcohol also decreased with a more educated family head). A possible explanation is that family heads with more education could be better informed of the health problems associated to the abusive consumption of tobacco and alcohol, or perhaps place a higher value on human capital. Hsieh [14] found that schooling has a positive effect on the probability of quitting smoking because it increases the efficiency of learning new risk information related to smoking. This result is also in agreement with findings from previous research using cross-section data for the US, UK and Spain (Farrely *et al.,* [7]; Jones [17]; and Garcia and Labeaga [9]).

Households with employed family heads spend less on tobacco than do households with unemployed family heads. The negative effect of employment on expenditures may reflect the fact that people with more active lifestyles may be more health conscious and then spend less on these goods than are others with a more sedentary lifestyle (Blaylock and Blissard [3]). It may also be a consequence of the increasing emphasis on a smoke-free work environment in Spain. Garcia and Labeaga [9], and Fry and Pashardes [8] also found a statistically significant negative effect of employment status on tobacco consumption.

Regional location also had an impact on tobacco and alcohol expenditures. The significance of the regional variables reflects differences among regions (in taste, prices, tax structure, lifestyles, advertising, etc.) that affect the level of expenditures on these goods. For regime 1, southern households spent more on alcohol and tobacco than did households located outside the peninsula. Northwestern and northeastern households also spent more on alcohol than did households of the reference group. Urban location had a positive impact on tobacco expenditures (regime 1) but a negative impact on alcohol expenditures (regimes 1 and 2). Garcia and Labeaga [9], Nayga [30], Heien and Pompelli [13], and Su and Yen [33] also found that regional location variables have a statistically significant impact on tobacco and alcohol consumption. Finally, the presence of male family heads had a positive impact on alcohol expenditures (regime 1). Su and Yen [33] also found that male household heads consumed more wine than their female counterparts.

CONCLUDING REMARKS

Standard double hurdle models do not consider the fact that a household's behavior is different when it consumes both tobacco and alcoholic beverages compared to when it only consumes tobacco or alcoholic beverages, and thus they do not account for the potential interaction between drinking and smoking either. In this research, we used Pena and Ruiz-Castillo's "adjusted for bulk purchase" expenditure data from the Spanish Household Survey 1990-91 to model Spanish household expenditures on tobacco and alcoholic beverages for different regimes.

We explicitly considered the potential correlation between the disturbance terms of the decision to purchase equations as well as the potential correlation between the disturbance terms of the decision to purchase and expenditure equations. Specifically, we used bivariate probit analysis and endogenous switching regression techniques to model these potential interactions considering the different structures of demand, namely when the tobacco and alcoholic beverages are consumed, only tobacco is consumed, and only alcoholic beverages are consumed.

Results from the bivariate probit analysis confirmed that the decisions to purchase tobacco and alcoholic beverages are statistically related. The empirical evidence has shown that income and household demographic variables are important determinants of both purchase and expenditures on tobacco and alcoholic beverages. However, the set of statistically significant factors in the participation and expenditure equations is not the same for both commodities.

Based on the empirical results, we conclude that for Spain, public policies, educational strategies and advertising intended to discourage both drinking and smoking should focus on high income, urban households with young, male main family heads, and households with more members 18 and older. Furthermore, it is important to recognize the interdependent nature of the two consumption goods. Policies intended to decrease the level of expenditures on tobacco should focus on high-income households and those with young, unemployed or less educated main household heads, renter families with more adult members. Public policies and education programs intended to decrease the level of expenditures on alcohol should focus on high-income, rural and renter households. These results may help policy makers to find support for the implementation of long-run non-price policies directed to discourage the consumption of these goods (like advertising and educational programs, emphasis on smoke-free public environments, etc.) and to anticipate the health effects of a higher consumption associated with European integration.

APPENDIX A

The conditional Engel equations for the different regimes are:

$$e_a = \beta_1'x_{a1} + \mu_{a1} \qquad (\text{ if } w_a^* = \delta_a'z_a + \zeta_a > 0 \ \}$$
$$e_t = \beta_2'x_{t1} + \mu_{t1} \qquad \text{and } w_t^* = \delta_t'z_t + \zeta_t > 0 \ ) \qquad \text{(A1)}$$

$$e_a = \beta_3'x_{a2} + \mu_{a2} \qquad (\text{ if } w_a^* = \delta_a'z_a + \zeta_a > \}$$
$$e_t = 0 \qquad \text{and } w_t^* = \delta_t'z_t + \zeta_t \leq 0 \ ) \qquad \text{(A2)}$$

$$e_a = 0 \qquad (\text{ if } w_a^* = \delta_a'z_a + \zeta_a \leq 0\}$$
$$e_t = \beta_4'x_{t3} + \mu_{t3} \qquad \text{and } w_t^* = \delta_t'z_t + \zeta_t > 0 \ ) \qquad \text{(A3)}$$

$$e_a = 0 \qquad (\text{ if } w_a^* = \delta_a'z_a + \zeta_a \leq 0 \ \}$$

$$e_t = 0 \qquad \text{and } w_t^* = \delta_t'z_t + \zeta_t \leq 0 \ ) \qquad \text{(A4)}$$

where e_a and e_t represent expenditures on tobacco and alcoholic beverages; x_{a1}, x_{t1}, x_{a2} and x_{t3} are vectors of explanatory variables; β_1, β_2 , β_3 and β_4 are parameter vectors; and μ_{a1}, μ_{t1}, μ_{a2} and μ_{t3} are disturbance terms. We assume that each of the triple sets of random disturbances (of each μ with ζ_a and ζ_t) has a trivariate normal distribution with mean vector 0 and covariance matrix Σ.

APPENDIX B

The probability of being included in each regime is determined from the evaluation of the following bivariate probabilities (Huffman and Lange [16]):

$$M_{11} = P \, [\, w_a^* = \delta_a'z_a + \zeta_a > 0 \ , \ w_t^* = \delta_t'z_t + \zeta_t > 0 \,] \qquad \text{(B1)}$$

$$M_{10} = P \, [\, w_a^* = \delta_a'z_a + \zeta_a > 0 \ , \ w_t^* = \delta_t'z_t + \zeta_t \leq 0 \,] \qquad \text{(B2)}$$

$$M_{01} = P \, [\, w_a^* = \delta_a'z_a + \zeta_a \leq 0 \ , \ w_t^* = \delta_t'z_t + \zeta_t > 0 \,] \qquad \text{(B3)}$$

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ENDNOTES

1. Keen [24], Jones [17], and Jones and Labeaga, [20] also suggested that zero tobacco expenditures were not the result of corner solutions.