Empir Econ (2009) 36:515–530
DOI 10.1007/s00181-008-0209-y

ORIGINAL PAPER

Alcohol demand among young people in Spain: an addictive QUAIDS

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Received: 15 October 2006 / Accepted: 15 January 2008 / Published online: 28 June 2008
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Abstract This paper analyzes the demand for alcoholic beverages among young people in Spain. To that end, we develop a theoretical model which combines elements from the Theory of Two-Stage Budgeting and the Theory of Addiction, with this being empirically translated into a Quadratic Almost Ideal Demand System (QUAIDS) in which the particular characteristics of young people are introduced by Price Scaling (PS) techniques. We then estimate this specification by using data drawn from the Spanish National Survey on Drug Use in the School Population (2000) and the Spanish National Household Survey (2000). Given that wine, beer and spirits all have normal demands, our results suggest that a tax increase imposed with the intention of reducing alcohol consumption would appear to be efficient.

Keywords Alcohol demand · Young people · Addictive QUAIDS

JEL Classification D12 · C31 · Q18

This paper was partially written while Ana Isabel Gil was a Visiting Researcher at the London School of Economics and Political Science, to which she would like to express her gratitude for the hospitality and facilities provided. An earlier version of this paper has been presented at the Spanish Economic Analysis Meeting-2003 (Sevilla, Spain) with all the comments made by the participants being appreciated. Finally, the authors would like to express their thanks for the financial support provided by the Spanish Ministry of Education-CICYT and the European Commission (Project 2FD97-2057). The usual disclaimer applies.

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1 Introduction

The analysis of alcohol demand constitutes a relevant topic that has been widely considered in a significant number of academic papers, which have presented evidence from many countries, for example, Selvanathan (1988), Atkinson et al. (1990) and Blake and Nied (1997) in the UK; Heien and Pompelli (1989), Yen (1994), Nelson (1997), and Yen and Lin (2002) using US data; Holm (1995) in Finland; and Andrikopoulos et al. (1997) using Canadian data. Against the background of the clear relevance of this body of literature, this paper is based on a number of particular characteristics which make the analysis of alcoholic beverages especially relevant. This is the case because, first, alcoholic beverages constitute addictive goods, whose characteristics of tolerance and reinforcement imply that earlier consumption determines present demand; secondly, given this addictive property, the analysis of alcohol demand is especially relevant among young people; and, thirdly, alcohol is a good subject for indirect taxes.

With respect to the first characteristic, alcohol addiction, based on a pattern of behavior that maximizes the utility obtained during the total lifetime of individuals, implies dependence between the current and the past consumption of the good through the concept of addiction stock (Becker and Murphy 1988; Becker et al. 1991, 1994; Waters and Sloan 1995). Thus, recognition is given to the existence of notions of tolerance, reinforcement and withdrawal. Tolerance suggests that a given level of consumption yields less satisfaction, as past cumulative consumption is higher. For its part, reinforcement implies a learned response to past consumption, whilst withdrawal refers to the negative physical reaction and other reductions in utility associated with the cessation or interruption of consumption.

Considering the second of the above characteristics in more detail, it is well-known that adolescents represent the most sensitive population group in terms of tendencies, peer pressure or, in general, external effects (Grossman et al. 1994; Cook and Moore 2000; Lundborg and Lindgren 2002). Thus, while these young people have yet to develop their own identity, they are more vulnerable to the risks of, among other things, experimenting with drugs. More particularly, although moderate alcohol consumption is not socially rejected in most developed countries, the consequences of taking this to abusive levels are nevertheless serious and wide ranging, in the form, for example, of illness, traffic fatalities or social conflicts. Some of these consequences, which directly influence the development of the adolescents' human capital, in the form of poor health or inadequate educational achievement, are not perceived immediately by the individual. Rather, their impact only emerges years later, as the consequence of the earlier-mentioned addictive and abusive pattern of consumption.

With respect to the third characteristic, indirect taxes represent one of the most commonly applied instruments to limit the abuse of alcohol on the part of adolescents, given that a higher tax rate increases the price of the addictive substance and, consequently, reduces the purchasing capacity. This approach relies on the fact that the alcohol abuse is a result, among others, of the fact that the price paid by consumers is lower than the marginal social cost of this consumption. In this way, and in order for the individual to correctly perceive the real cost of consuming alcoholic beverages, the taxes should be increased until that part of consumption derived from the excess of social cost over the individual's utility is eliminated (Pogue and Sgontz 1989; Saffer and Chalopuka 1994; Crawford and Tanner 1995; Crawford et al. 1999).

Against this background, in this paper we analyze the demand for alcoholic beverages among young people in Spain in the particular context that emerges from the simultaneous consideration of these salient characteristics, namely the addictive nature of the good, the special vulnerability of young people and indirect taxes. To that end, we characterize a theoretical framework in which elements from the Theory of Two-Stage Budgeting and the Theory of Addiction are introduced. This model is empirically translated to a Quadratic Almost Ideal Demand System (QUAIDS) in which the particular characteristics of young people are introduced by Price Scaling (PS) techniques. This specification is then estimated by using data drawn from the Spanish National Survey on Drug Use in the School Population (2000), as well as from the Spanish National Household Survey (2000). Finally, our empirical results will hopefully allow us to derive a better understanding of the alcohol demand among young people, which must represent the appropriate starting point when seeking to achieve the goal of reducing this consumption.

The rest of the paper is organized as follows. In Sect. 2 we specify the theoretical framework. Section 3 is dedicated to describing the data and the estimation method. The empirical results are considered in Sect. 4 and, finally, Sect. 5 closes the paper with a summary of the most relevant conclusions.

2 The theoretical framework

As we have already stated, in this paper we characterize a theoretical framework which combines elements from the Theory of Two-Stage Budgeting and the Theory of Addiction. First, we describe how individuals decide to allocate their available budget into the different groups of products according to the Theory of Two-Stage Budgeting. We then correct the price of the alcoholic beverages using the Theory of Addiction. Subsequently, we formulate the QUAIDS model and introduce the characteristics of the addictive goods in the original demand functions by substituting the market prices for the shadow prices.

Two-stage budgeting constitutes an ideal mechanism for a suitable response to the most important economic decisions taken by consumers, that is to say, the allocation of expenditure to specific consumption goods (Strotz 1957; Gorman 1959; Deaton and Muellbauer 1980). This method postulates that agents allocate total expenditure to broad groups of goods, based on a price index for each group, and then allocate expenditure within each of these groups, based on group individual prices and group expenditures. Two-stage budgeting has often been implemented for different kinds of goods, mainly agricultural (Michalek and Keyzer 1992; Carpentier and Guyomard 2001; Gustavsen and Rickertsen 2003), but also for energy and other goods (Baker et al. 1989; Jorgenson et al. 1997; Molina 1997). In this context, the two-stage budgeting provides the most useful framework to study the demand for products under different levels of disaggregation, by calculating income and price elasticities. Because taxes are usually charged on goods, the price elasticities bring to light useful information for analyzing tax efficiency.

Two-stage budgeting pertains to our specific framework, given that our representative consumer takes decisions in two steps. First, allocating expenditures among broad classes, and then allocating the resulting expenditure among specific drinks (wine, beer and spirits), with this second level being used to impose taxes. Thus, this mechanism allows us to calculate price elasticities at the beverage level, with this disaggregation helping to justify the appropriateness of tax rates by using simulation techniques. The main reason different tax rates are imposed on different drinks lies in the existing relation between negative externalities and alcohol content.

Thus, in the first stage the individual has to face a problem of maximization of the utility subject to the total budget restriction, in which the consumption of different goods and services, including alcoholic beverages, is defined. To carry out this process, we assume a utility function, $U = U\left(U_A\left(x_A\right), x_Z\right)$, where U_A is the utility of the alcoholic drinks, with x_A aggregating all these drinks, that is to say, $x_A = A\left(x_W, x_B, x_S\right)$, and where x_W represents wine consumption, x_B beer consumption and, finally, x_S spirits consumption. At the same time,x_Z refers to the consumption of the remaining goods and services. In these circumstances, the budget restriction adopts the form $M = P_A x_A + P_Z x_Z$, where M is the total expenditure, P_A the aggregated price of the alcoholic drinks and P_Z the price of the aggregated goods and services. From maximizing the utility function subject to the budget restriction, we derive the Marshallian demand function of the addictive good, which expresses the optimal expenditure on alcoholic drinks, M_A, as a function of P_A, P_Z and M.

Once having obtained M_A, we are in a position to proceed with the second stage of the model, in which the consumers allocate this optimal expenditure on the acquisition of different kinds of alcoholic drinks, that is to say, wine, beer and spirits. This allocation results from the maximization of the utility function corresponding to the alcoholic drinks, $U_A = U_A\left(U_W\left(x_W\right), U_B\left(x_B\right), U_S\left(x_S\right)\right)$, subject to the budget restriction $M_A = P_W x_W + P_B x_B + P_S x_S$. The resolution of this problem allows us to express the specific optimal expenditures, M_i, as a function of P_W, P_B, P_S and M_A.

According to the Theory of Addiction, the price of alcoholic drinks is undervalued, and, in order to introduce their real price in the maximization process, we must take into account the negative externalities of their consumption. To correct this weakness, we include the addiction stock in the specific utility functions by defining the preferences as follows: $U_i = U_i\left(x_i\right) = u_i\left(x_i^*\right)$, where $x_i^* = \phi\left(x_i, S\right)$ are intermediate goods produced by the consumer, and with S being a scalar that represents the past consumption of the addictive goods, such as $S = S_W + S_B + S_S$.[1]

Subsequently, the addictive expenditure functions will be specified in terms of the intermediate goods related to A and x_i, that is to say, A^* and x_i^*, by using their shadow prices, $A^*\theta\left(P_A, S\right)$ and $x_i^*\theta\left(P_i, S\right)$. These intermediate goods have to be independent of the consumption of the different groups of alcoholic beverages, with this condition being satisfied if: $A^* = \phi\left(A, S\right) = Ag\left(S\right)$ and $x_i^* = \phi\left(x_i, S\right) = x_i g\left(S\right)$.[2] The use of this formulation imposes two assumptions. On the one hand, we are assuming that the present consumption only depends on the past consumption, because the individual

[1] We adopt this form because we are considering goods that belong to the same group, and so we assume that all of them define the same addiction stock (Bask and Melkersson 2001).

[2] For details, see Appendix A.

cannot foresee the future implications of present consumption. This means that the individual takes decisions myopically (Becker et al. 1994) instead of rationally (Becker and Murphy 1988; Becker et al. 1991; Waters and Sloan 1995). On the other, and in order to easily introduce the addictive characteristic into the demand system, we are also assuming that x_i^* is produced by constant returns to scale, with this implying that the shadow price of the intermediate good, x_i^*, is equal to the price of the good acquired in the market, x_i, divided by the marginal productivity in the production of x_i^*, that is to say, $P_i / g(S)$ or, what is the same, $P_i h(S)$.

In this context, we use the QUAIDS model, with its main advantage for estimating a two-stage budgeting model being that it is a system designed to analyze budget participation in different goods (Decoster and Vermeulen 1998). Additionally, the use of QUAIDS for addictive goods, as in our case, is not new (for example, Jones and Mazzi 1996), with the particular introduction of the addiction stock as a variable of the QUAIDS, thus incorporating the characteristics of tolerance and reinforcement as fundamentals in the addictive goods, has been previously studied in Escario and Molina (2000).

The QUAIDS model, derived from a utility maximization process, which generates a rank 3 system, with this rank being defined as the expansion space of the Engel curve (Lewbel 1991; Banks et al. 1997), is characterized by the following indirect utility function:[3]

$$\ln V = \left\{ \left[\frac{\ln M_A - \ln a(P)}{b(P)} \right]^{-1} + \lambda(P) \right\}^{-1} \tag{1}$$

where $a(P)$, $b(P)$ and $\lambda(P)$ are defined to be homogeneous functions of degree zero in prices, with the first element in the bracket is the indirect utility function of a PIGLOG demand system. Applying Roy's Identity in Eq. (1), the budget share for the commodity i is:

$$w_i = \frac{\partial \ln a(P)}{\partial \ln P_i} + \frac{\partial \ln b(P)}{\partial \ln P_i} (\ln M_A) + \frac{\partial \lambda}{\partial \ln P_i} \frac{1}{b(P)} (\ln M_A)^2 \tag{2}$$

with $w_i = \left(p_i x_i / M_A \right)$ representing this budget share.

Given that the budget share allocated to acquire x_i is the same as that allocated to x_i^*, we introduce the characteristics of the addictive goods in the QUAIDS demand functions by substituting the market prices for the shadow prices. The QUAIDS allows us to define the prices as a function of $h(S)$, so the budget share will be lineal in the logarithm of the factors. Additionally, we will require the logarithm of the addiction stock for which we assume that $h(S) = S$. In these circumstances, the shadow prices will be: $P_i^* = P_i b(S) = P_i S$.

[3] The model is simply a transcript for the second stage given that, for the first, the adaptation is quite similar. We have omitted the formulation in order to better present the results, but the formulas are available upon request.

Further, we assume that:

$$\ln a^{*}(P) = \alpha_0 + \sum_{i=1}^{n} \alpha_i \ln (P_i S) + \frac{1}{2} \sum_{i=1}^{n} \sum_{j=1}^{n} \gamma_{ij} \ln (P_i S) \ln \left(P_j S\right) \tag{3}$$

$$b^{*}(P) = \prod_{i=1}^{n} (P_i S)^{\beta_i} \tag{4}$$

$$\lambda^{*}(P) = \sum_{i=1}^{n} \lambda_i^{*} \ln (P_i S) \quad \text{where} \sum_{i} \lambda_i^{*} = 0. \tag{5}$$

The above system will be consistent with Demand Theory if it satisfies the following conditions: (i) Aggregation: $\sum_i \alpha_i = 1, \sum_i \gamma_{ji} = 0$, (ii) Homogeneity: $\sum_j \gamma_{ji} = 0$ and, (iii) Symmetry: $\gamma_{ji} = \gamma_{ij}$

Substituting (3), (4) and (5) in (2), we obtain the Addictive QUAIDS functions in terms of expenditure budget shares:

$$w_i = w_i^{*} = \alpha_i + \sum_{j=1} \gamma_{ij} \ln P_j + \beta_i \ln \left[\frac{M_A}{a^{*}(P)}\right] + \frac{\lambda_i^{*}}{b^{*}(P)} \left\{\ln \left[\frac{M_A}{a^{*}(P)}\right]\right\}^2 + \nu_i \ln S \tag{6}$$

with the main difference with respect to the demand system of non-addictive good and services being the introduction of the last element, which represent the influence of the addiction stock over the budget share allocated to commodity i.

Up to this point, the model explains the individual budget share in the different groups of alcoholic beverages by reference to the available income. However, it does not take into account other kinds of factors, such as individual age or gender and, in these circumstances, we consider it necessary to introduce the demographic effect in the estimation (Michelini 1999; Lancaster et al. 1999). To that end, we use the Price Scaling Technique (PS) defined by Ray (1983), under which the income is deflated by an equivalence scale such as: $m_0(h) = 1 + \sum_{d=1}^{D} \theta_d h_d$, where $h(h_1, h_2, \ldots, h_D)$ is a vector of individual characteristics that we limit to one variable: *GoingOutNight*. Introducing this deflator, the budget share of the good i is finally defined as:

$$w_i = \alpha_i + \sum_{j=1} \gamma_{ij} \ln P_j + \beta_i \ln \left[\frac{M_A}{a^{*}(P)\, m_0}\right] + \frac{\lambda_i^{*}}{b^{*}(P)} \left\{\ln \left[\frac{M_A}{a^{*}(P)\, m_0}\right]\right\}^2 + \nu_i \ln S \tag{7}$$

We complete the analysis of the budget share by calculating the expenditure elasticities. To that end, we take into account that $e_{iM_A} = 1 + \mu_i / w_i$, where $\mu_i = \partial w_i / \partial \ln (M_A)$, in such a way that from (7) we obtain the expenditure elasticity for the good i:

$$e_{iM_A} = 1 + \frac{\beta_i}{w_i^*} + \frac{2\lambda_i^* \ln\left(M_A/m_0 a^*(P)\right)}{w_i^* b^*(P)} \tag{8}$$

Weak separability of preferences permits the estimation of expenditure elasticities for the second stage, both with respect to total expenditure, e_{iM}, and with respect to the specific alcohol expenditure, e_{iM_A}:

$$e_{iM} = e_{iM_A} e_i \tag{9}$$

where e_i denotes the total alcohol expenditure elasticity with respect to total expenditure, which has been calculated in the first stage (Manser 1976).

The Marshallian price elasticities are obtained as $e_{ij}^M = -\delta_{ij} + \left(\mu_{ij}/w_i\right)$, where $\mu_{ij} = \partial w_i/\partial \ln\left(P_j\right)$ with $\delta_{ij} = 1$ for $i = j$, and 0 otherwise:

$$e_{ij}^M = -\delta_{ij} + \frac{\gamma_{ij}}{w_i^*} - \frac{\mu_i}{w_i^*}\left(\alpha_j + \sum_k \gamma_{jk} \ln(P_k)\right) - \frac{\lambda_i^* \beta_j \ln\left(M_A/m_0 a^*(P)\right)^2}{w_i^* b^*(P)} \tag{10}$$

Finally, once having obtained the income and Marshallian price elasticities, we can also deduce the Hicksian price elasticities through the Slutsky equation:

$$e_{ij}^H = e_{ij}^M + e_{iM_A} w_j \tag{11}$$

3 Data and estimation method

The empirical application of this work is carried out by using the data drawn from two national surveys. Thus, in order to obtain the necessary information about the individual, we have used the Spanish National Survey on Drug Use in the School Population (2000), whilst the prices of the alcoholic beverages have been obtained from the Spanish National Household Survey (2000).

From the Spanish National Survey on Drug Use in the School Population, we have drawn a sub-population of 16,306 whose ages fall between 14 and 18, and who have provided answers to all the questions necessary in order to specify the model. Thus, if students confirm having consumed alcoholic beverages in the last week, the empirical model requires computing the number of consumed alcoholic beverages; otherwise, the observations are treated as missing. Given that the use of QUAIDS implies logarithm transformations of the variables, we only consider those students whose weekly expenditure is at least equal to 1 Euro.[4] From this technical constraint, we have considered the whole selected sample in the first stage, whereas in the second stage, we only included students whose expenditure on alcoholic beverages was positive.

[4] The lost of observations because of this reason was insignificant.

Despite the Spanish Survey of Households' Budgets (Spanish National Institute of Statistics) also providing information on alcohol consumption, this survey has a disadvantage in that it limits the questions about alcohol to the acquisition of alcoholic beverages in supermarkets, thus ignoring alcohol consumption that takes place in restaurants or in other public places. Given the social character of drinking, a survey such as the Spanish National Survey on Drug Use in the School Population, which compiles the total number of consumed alcoholic drinks, is better suited to our goals. The set of questions that our survey provides is wide-ranging. We took into account three kinds of questions whose reference time is the week prior to the interview: (a) have you consumed alcoholic beverages in the last week?; (b) in that case, which alcoholic beverages have you consumed?; (c) and how many drinks of the following alcoholic beverages have you had? The responses to these questions have been computed in order to consider, in the first stage, the total number of consumed alcoholic drinks, whereas in the second stage we disaggregate this total number of alcoholic beverages into three categories: wine (wine and champagne), beer, and liquors (cocktails, strong liquors, and fruit liquors).

With respect to the Spanish National Household Survey, this interviews around 6,000 households every year, with the alcoholic drinks' prices being calculated from both the household's average expenditure on them and the average quantity demanded.

Let us first offer some descriptive statistics aimed at providing an indication of the scale of alcohol demand among adolescents in Spain. Mean and standard deviations of the variables appear in Table 1. The dependent variables for the two equations of the model are *Alcohol* (first stage) and *Wine*, *Beer* and *Spirits* (second stage), whilst we have considered a number of independent variables, that is to say, *GoingOutNight, DrinkingYears*, *AlcoholPrice, OtherPrice*, *WinePrice*, *BeerPrice* and, finally, *SpiritsPrice*. As we do not have the consumption in the last period, we consider *DrinkingYears* to be best option for introducing the concept of addiction stock into the empirical model. Given that we are focusing on a population group that is characterized as having an age interval of four years from the oldest to the youngest, we consider that *DrinkingYears* provides us with an indication of how early these young people started to consume alcoholic beverages and for how long. Individuals who start to consume such beverages earlier will have a higher tendency of becoming addicted and, similarly, the number of years that an individual has been consuming them is positively correlated with the tendency of continuing their consumption (National Institute on Alcohol Abuse and Alcoholism 1995).

With respect to the endogenous variables, we find that young people allocate on average some 14.43% of their budget to the acquisition of alcoholic drinks. We can further note that 15.86% of the budget so allocated is to buy wine, 18.72% to buy beer and 65.40% to buy different spirits. With respect to the exogenous variable, the descriptive analysis reveals that when these young people go out at night near once per week.

As regards the prices, the Spanish National Household Survey takes into account the average price from the individual regional prices (Table 2). Thus, we find that the highest prices for wine are found in the Balearic Islands, the Basque Country and Cantabria, while the lowest are in Extremadura, the two Castilles, as well as in Asturias. As regards beer, its highest prices are found in the Basque Country, the Canary Islands

Table 1 Variables

Variable	Definition	Mean (SD)
Alcohol	Adolescent's budget share allocated to alcoholic drinks	0.144(0.196)
Wine	Adolescent's budget share allocated to wine	0.158(0.318)
Beer	Adolescent's budget share allocated to beer	0.187(0.370)
Spirits	Adolescent's budget share allocated to spirits	0.654(0.443)
GoingOutNight	This takes a value according the frequency of going out at night during the week (1 never; 2 occasionally; 3 one or less; 4 between 2 or 3; 5 more than 3)	2.899(1.047)
DrinkingYears	Number of years drinking alcohol	2.432(2.006)
Expenditure	Weekly expenditure (Euros)	12.6335(12.4543)
AlcoholPrice	Price of alcoholic drinks	0.550(0.583)
OtherPrice	Price of other goods and services	0.519(0.185)
WinePrice	Price of wine	0.376(0.404)
BeerPrice	Price of beer	0.166(0.177)
SpiritsPrice	Price of spirits	1.109(1.112)

Table 2 Prices and taxes

Region	Price before taxes			Tax rate (%)		
	Wine	Beer	Spirits	Wine	Beer	Spirits
Andalucia	0.3880	0.1276	0.9052	16.00	16.81	18.53
Aragon	0.3578	0.1477	1.0261	16.00	16.70	18.24
Asturias	0.3332	0.1490	0.6994	16.00	16.69	19.28
The Balearic Islands	0.4292	0.1430	1.0508	16.00	16.72	18.18
The Canary Islands	0.3741	0.1511	0.8991	16.00	16.68	18.00
Cantabria	0.4040	0.1503	0.8778	16.00	16.68	18.61
C. Mancha	0.3215	0.1284	0.8810	16.00	16.80	18.60
C. Leon	0.3386	0.1323	0.8843	16.00	16.78	18.59
Cataluña	0.3717	0.1435	0.8813	16.00	16.72	18.60
Valencia	0.3528	0.1265	0.8854	16.00	16.81	18.59
Extremadura	0.2981	0.1433	0.9176	16.00	16.72	18.50
Galicia	0.3478	0.1448	0.8871	16.00	16.71	18.59
Madrid	0.3767	0.1418	0.9917	16.00	16.72	18.31
Murcia	0.3511	0.1314	0.9320	16.00	16.78	18.46
Navarra	0.3779	0.1456	0.9906	16.00	16.71	18.32
The Basque Country	0.4197	0.1542	0.9394	16.00	16.67	18.44
Rioja	0.3755	0.1264	0.8292	16.00	16.81	18.77

and Cantabria, and the lowest in Rioja, Valencia and Castilla La Mancha. Finally, with respect to spirits, the highest prices appear in the Balearic Islands, Aragon and Madrid, and the lowest in Asturias, Rioja and Castilla La Mancha.

In order to introduce the effects of taxes we will carry out two theoretical exercises in which we measure the impact of raising the tax on liquors and wine by 10%, both on its own demand and on the demand for the other alcoholic beverages. We focus on the liquors group because its price elasticity is close to one and because these beverages are characterized by their higher ethanol content as compared with wine and beer. The first of these two reasons implies that the effect of a tax increase will be higher for the demand for liquors due to their elasticity, whilst the demand for beer and wine are inelastic, in such a way that their demand will hardly fall in response to a tax increase. With respect to the second, the consumption of liquors is related to worse negative externalities, which justifies their higher tax rate. The reason for repeating the exercise for the case of wine is because this product is exempt from special taxes, with the aim being to maintain the competitive levels of national wineries as compared to those of third-party countries. This situation is currently promoting a debate about the need to burden wine with the levying of these kinds of taxes.

This tax analysis is carried out on the basis of a number of simplifying assumptions, because, save for wine, the other alcoholic drinks support a special indirect tax based on their alcohol content. Thus, whilst wine exhibits a constant tax rate equal to 16%, for the remaining alcoholic drinks this percentage is higher. Furthermore, as the tax rate is related to the alcohol content, those regions where the price of an alcoholic drink is lower will be burdened with a higher final tax percentage. When considering these regions, there is only one case that requires particular attention, namely that of the Canary Islands, in as much as spirits support a tax rate lower than that applied in the rest of Spain.

With respect to the estimation procedure, the adding-up condition is maintained in the estimation and, therefore, one equation is omitted given the singularity of the system. Thus, the stochastic version of the model can be written as:

$$w = f(\theta, x) + e \tag{12}$$

where w is the vector of dependent variables, namely $n-1$ expenditure shares, θ is the vector of all parameters to be estimated, x corresponds to the exogenous variables and e is the vector of error terms. As regards these, we assume that the model satisfies the standard assumptions on the error terms, that is to say, that they are normally distributed, serially uncorrelated and contemporaneously correlated. Given these assumptions, the model is jointly estimated by Maximum Likelihood (ML), with this estimation being consistent and asymptotically efficient. The coefficients and t-ratios from the omitted equations are obtained, on the one hand, by imposing the conditions of aggregation, homogeneity and symmetry and, on the other, from considering λ to be a differentiable and homogeneous function of degree zero of prices P.

4 Empirical results

In this Section we present the results of the estimations, beginning with the estimations related to the first stage and then turning to those related to the second.

Table 3 contains the estimation of the QUAIDS model for the group of alcoholic drinks, with all the estimated coefficients being significant at the 1% level. The main

Table 3 Estimation of the QUAIDS model (first stage)

	Alcoholic beverages		Other goods and services	
	Coefficient	SD	Coefficient	SD
Constant	0.4191[a]	0.0049	0.5808[a]	0.0049
AlcoholPrice	−0.0045[a]	0.0011	0.0045[a]	0.0011
OtherPrice	0.0045[a]	−0.0011	−0.0045[a]	−0.0011
DrinkingYears	0.0001[a]	0.0001	−0.0001[a]	0.0001
Expenditure	0.0140[a]	0.0026	0.0203[a]	0.0069
Expenditure^2	−0.0069[a]	0.0003	0.0069[a]	0.0003
Income elasticities	0.9884[a]	0.0008	1.01169[a]	0.0007

[a] Indicates individual significance at the 1% level

point to which attention should be drawn is the decreasing demand of this aggregate; that is to say, that if the price of these alcoholic beverages increases, then their demand will decrease. As regards *DrinkingYears*, we can observe that, according to the addition theories, the longer the individual has been demanding alcoholic beverages, the higher will be the expenditure share allocated to these products. The expenditure elasticities reveal that the alcoholic beverages are necessities. Having said that, this result should be viewed with caution when we recall that the value of this elasticity is close to one, implying they these beverages could also behave as luxuries.

In Table 4, we present the estimation of the QUAIDS model for each alcoholic beverage. Again, all variables considered, save one, are significant at the 1% level. We can first note that the addiction stock is positively correlated to the budget share corresponding to spirits, but negatively correlated to that corresponding to beer and wine. This seems reasonable in the light of the fact that spirits generally contain a higher pure alcohol content. Moreover, we can appreciate that the frequency of going out at night tends to reduce the individual's available budget. This variable has a negative effect on the calculation of the deflator, in the sense that, of two adolescents who have the same available budget for consuming alcoholic drinks, the one who goes out at night more often will have a greater deflated budget. As regards the available budget allocated to purchasing alcoholic drinks, this has a negative influence over the demand for wine and spirits, but a positive one over the demand for beer. This gap will be reduced more than proportionally as the adolescent's budget increases. As regards the variable *DrinkingYears*, we find that the longer the individual has been consuming alcoholic beverages, the higher will be the budget share allocated to liquors as compared to those allocated to wine and beer. This result is also coherent with Addiction Theory when we recall that liquors have a higher ethanol content, with their consumption thereby accelerating the additive characteristics of tolerance and reinforcement.

Expenditure elasticities reveal that wine is a necessity, whereas beer and spirits are luxuries, with these results appearing for both the elasticities with respect to the total expenditure and for the specific elasticities with respect to the expenditure on alcoholic beverages.

Table 4 Estimation of the QUAIDS model (second stage)

	Wine		Beer		Spirits	
	Coefficient	SD	Coefficient	SD	Coefficient	SD
Constant	1.2196[a]	0.0204	−0.2903[a]	0.0292	0.0707[a]	0.0226
DrinkingYears	−0.0037[a]	0.0001	−0.0015[a]	0.0001	0.0052[a]	0.0001
WinePrice	0.1239[a]	0.0098	−0.1007[a]	0.0067	−0.0372[a]	0.0053
BeerPrice	−0.1565[a]	0.0051	0.2202[a]	0.0063	−0.0653[a]	0.0045
SpiritsPrice	0.0326[a]	0.0069	−0.1195[a]	0.0059	0.1027[a]	0.0033
ExpenditurePS	−0.2142[a]	0.0057	0.1978[a]	0.0075	−0.0945[a]	0.0122
ExpenditurePS^2	−0.8214[a]	0.0118	−0.0114[a]	0.0015	−0.0155[a]	0.0013
Income elasticities						
e_{iM}	0.7303[a]	0.0187	1.0078[a]	0.0118	1.6675[a]	0.0612
e_{iM_A}	0.7389[a]	0.0190	1.0197[a]	0.0120	1.6871[a]	0.0620
Price elasticities						
Marshallian						
Wine	−0.3867[a]	0.0328	−0.4271[a]	0.0644	−0.0530[a]	0.0135
Beer	−0.4718[a]	0.0307	−0.5728[a]	0.0669	0.1054[a]	0.0166
Spirits	0.2535[a]	0.0476	−0.0954[a]	0.0270	−1.0424[a]	0.0098
Hicksian						
Wine	−0.2579[a]	0.0272	−0.2982[a]	0.0673	0.0758[a]	0.0151
Beer	0.0671[a]	0.0245	−0.0338	0.0693	0.6444[a]	0.0180
Spirits	0.4748[a]	0.0360	0.1257[a]	0.0313	−0.8211[a]	0.0124

The expenditure is deflated through PS techniques by number of nights out whose coefficient has the estimated value of −0.8214 with a t-rate of −69.3164

[a] Indicates individual significance at the 1% level

This table also contains the price elasticities for each group of alcoholic drinks. Note that, in most of the cases, these elasticities are significant at the 1% level. When analyzing the Marshallian direct price elasticity, we find that all demands are normal, with the elasticity corresponding to beer and wine being inelastic, given that their absolute values are close to 0.5. In the particular case of spirits, this absolute value is close to 1, so that a reduction of 10% in the price will imply an increase of 104.24% in the quantity demanded. Finally, according to the Hicksian crossed price elasticities, it would appear that most of the alcoholic drinks behave as substitutes in that, if the price of one alcoholic drink increases, so the demand of the other drinks also increases. In short, the signs of these elasticities associated with the different alcoholic drinks provide us with a first indication of the impact of fiscal policies when these take the form of indirect taxes. Thus, if policy makers plan to increase the tax collection coming from a particular alcoholic drink, they must also consider the collateral effect produced over the remaining beverages.

Finally, with respect to taxes, we have analyzed how an increase in the rates levied will modify both the tax collection and the levels of consumption of alcohol. In this regard, we find that an increase of 10% in the liquor taxes will increase its final price by 1.53% in the Canary Islands and by 1.62% in Asturias. Thus, a tax increase of 10% leads to a reduction in demand for these beverages of around 1.6%. As regards the effect produced in the demand for wine and beer, we can observe that the demand for the former increases by 0.40%, whilst for the latter it falls by 0.15%. These findings are relevant for policy makers if their aim is to reduce the abusive consumption of alcohol, given that an increase in the liquor taxes will lead to a significant fall in the demand for liquors. However, at the same time, such a tax increase will produce collateral effects, dramatically increasing the demand for wine and hardly reducing the demand for beer.

In the light of all this, we must be careful when analyzing the global effects in such a way that we avoid the circumstances whereby the consumption of one substance is transferred to that of another which may be even more pernicious. According to the Spanish National Survey on Drug Use in the School Population (2000), a teenager demands 0.90 glasses of wine, 1.15 beers and 2.93 liquors per week, so the average weekly tax collection per young person is around 0.5733 Euros. If we introduce an increase in the liquor taxes of 10%, the total collection will fall by 0.0077 Euros, that is to say, by 1.34%. However, if we are interested in knowing what the reduction in the actual ethanol consumption will be, then we should focus on the weekly demand for this substance, where we find that the average weekly consumption of ethanol is 131.63 grams before the tax increase, whereas it falls to 1.65 grams after the increase, with this representing a decline in consumption of 1.25%.[5] If we repeat the exercise by increasing the tax on wine by 10%, the average increase in the price will again be around 1.60%, in such a way that this tax increase will lead to a reduction in the demand for wine of around 0.61%. At the same time, it will lead to a reduction in the demand for beer and liquors of 0.68% and 0.08%, respectively. Taking these results into account, the total tax collection will fall by only 0.0009 Euros, or 0.16%. As regards the reduction in the consumption of ethanol, this will be in the order of 0.25 grams, a fall of 0.19%.

5 Conclusions

In this study, we have set out to analyze the demand for alcoholic drinks on the part of the Spanish adolescent population. Our results suggest that a higher price of alcoholic drinks does indeed have the effect of reducing their demand. Therefore, a tax increase imposed with the intention of reducing alcohol consumption would appear to be efficient. We have also drawn attention to the possible relevance of the collateral effects, bearing in mind that the price of one specific alcoholic drink has a certain impact over the consumption of the remaining drinks.

The magnitude of these effects is relevant for the debate on the tax equality among different kinds of alcoholic drinks. It is interesting to observe that the only alcoholic drink which is exempt from the special indirect taxes in Spain, that is to say, wine, will potentially be best candidate for a tax increase if the government's priority is to

5 The average content of ethanol per drink is 15 grams for wine, 11 grams for beer and 36 grams for liquors, taking into account that is 48 grams of ethanol for strong liquors and 24 for fruit liquors.

reduce alcohol consumption. However, we should recall that, together with the positive health effects associated with moderate wine consumption, the main reason why this beverage does not have this indirect tax levied on it is to protect the competitiveness of European wine producing countries. Beyond any conflict of interests, agricultural policy makers at both the national and EU levels must be clear about precisely what goals they are pursuing.

In this paper, we have found evidence that to burden wine with higher taxes will lead to hardly any reduction in the demand for alcoholic beverages as a whole and, at the same time, will not increase the economic resources available to the State. On the other hand, by analyzing the effects of an increase in liquor taxes, we have confirmed that imposing higher levels of tax on those beverages that have a greater ethanol content will have a globally positive effect on reducing the weekly consumption of alcohol.

Another interesting result that emerges from our study is the validity of the addictive characteristics of alcohol. Omitting the addiction stock might imply measurement failures in the sense that, although a higher price reduces the demand for alcoholic drinks, this effect will be lower depending on the length of the period during which the individual has been consuming them. The only effective way to avoid adolescents becoming addicted to alcohol is to isolate them from it. As this is clearly inoperable, governments will have to define policies which not only limit adolescents' access to alcohol as much as possible, but also help them to reduce their consumption or overcome their addiction.

Appendix A

The expenditure function for the first level is:

$$G\left(P_A, P_Z, S, U_A\right) = \underset{A,Z}{\text{Min}}\left[P_A A + P_Z Z : U_A = U_A\left(U_A(A), Z\right)\right] \qquad \text{(A.1)}$$

and, similarly, for the second level:

$$\begin{aligned} &G\left(P_C, P_V, P_L, S, U_A\right) \\ &\quad = \underset{x_C, x_V, x_L}{\text{Min}}\left[\sum_{i=C,V,L} P_i x_i : U_A = U_A\left(U_C\left(x_C\right), U_V\left(x_V\right), U_L\left(x_L\right)\right)\right] \qquad \text{(A.2)}\end{aligned}$$

These functions can be easily expressed in terms of the intermediate goods related to A and x_i, that is to say, A^* and x_i^*, by simply substituting them in the expenditure function. These changes would only be possible if we have available to us the price of these intermediate goods. In their stead, and as good approximations, we use their shadow prices. For the first and second level, we obtain the following expressions:

$$G\left(P_A, P_Z, U_A\right) = \underset{A^*,Z}{\text{Min}}\left[A^* \theta_A\left(P_A, S\right) + P_Z Z : U_A = U_A\left(u_A\left(A^*\right), Z\right)\right] \qquad \text{(A.3)}$$

$$G\left(P_C, P_V, P_L, U_A\right) = \underset{x_C^*, x_V^*, x_L^*}{\mathrm{Min}} \left[\sum_{i=C,V,L} x_i^* \theta_i \left(P_i, S\right) : U_A = U_A \left(u_C \left(x_C^*\right), u_V \left(x_V^*\right), u_L \left(x_L^*\right)\right) \right] \tag{A.4}$$

where $A^* \theta_A \left(P_A, S\right)$ and $x_i^* \theta_i \left(P_i, S\right)$ are the shadow prices for A^* and x_i^*, respectively. As (A.3) and (A.4) satisfy the expenditure definition, we can express the expenditure functions as follows:

$$M = G\left(P_A, P_Z, S, U\right) = G\left(\theta\left(P_A, P_Z, S\right), U\right) \tag{A.5}$$

$$M_A = G\left(P_C, P_V, P_L, S, U_A\right) = G\left(\theta\left(P_C, S\right), \theta\left(P_V, S\right), \theta\left(P_L, S\right), U_A\right) \tag{A.6}$$

Finally, if we substitute the shadow prices for their expressions $P_A h\left(S\right)$ and $P_i h\left(S\right)$, we obtain:

$$M = G\left(P_A, P_Z, S, U\right) = G\left(P_A h\left(S\right), P_Z, U\right) \tag{A.7}$$

$$M_A = G\left(P_C, P_V, P_L, S, U_A\right) = G\left(P_C h\left(S\right), P_V h\left(S\right), P_L h\left(S\right), U_A\right) \tag{A.8}$$

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