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Modeling the optimal fiscal policy on tobacco consumption

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Abstract

In this paper we model the optimal fiscal policy on three types of tobacco, namely, Virginia, black and cigars, as an instrument for controlling the social costs generated by their consumption. This fiscal policy takes the form of optimal taxes on the three goods, with these being derived on the basis of the price elasticities obtained from the estimation of an Addictive and Linear Almost Ideal Demand System (ALAIDS). When considering Spanish time-series (1964–1995), we find that the homogeneous and symmetric version of the model allows us to obtain the optimal taxes, which exhibit very small differences when compared to the social costs generated by the consumption of the three types of tobacco.

JEL classification: H21; K34; D11; D12

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1. Introduction

The governments of the majority of Western countries are currently being subjected to social pressures aimed at forcing them to adopt economic policies that will act as a disincentive to the consumption of tobacco. It is argued that such

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policies should include, for example, the imposition of a special tax on tobacco consumption, or restrictions on its sale or advertising. Concentrating on the first of these policy options, the literature on optimal fiscal policy has focused on comparing the current tax with the generated social costs, in the sense that for such a tax to be set at an economically efficient level, it must at least cover the costs to others that arise from smoking (Barlett, 1988; Mackenzie, Bartechi, & Schrier, 1994; Manning, Keeler, Newhouse, Sloss, & Wasserman, 1989). In this context, theoretical models have usually been developed that allow us to determine the optimal tax by maximizing a welfare function which considers the impact of the tax on the demand and, therefore, on the social costs generated by the good itself, as well as by complementary and substitute goods (e.g., Saffer & Chaloupka, 1994).

Against this background, the objective of this paper is to model the optimal fiscal policy for three types of tobacco, that is to say, Virginia, black and cigars, as an instrument for controlling the social costs generated by their consumption. This fiscal policy takes the form of individual optimal taxes on the three goods, with these being derived from the price elasticities obtained from estimating a particular demand system which characterizes the demand behavior of smokers. In recent years this procedure has been carried out by estimating functional forms which include the addictive character of tobacco consumption (Becker, Grossman, & Murphy, 1994; Chaloupka, 1991). Our paper follows this line, after having previously illustrated this addictive character for Spain in an earlier work (Escario & Molina, 2001). Furthermore, it also models the behavior of smokers using an addictive version of the Linear Almost Ideal Demand System (LAIDS), of Deaton and Muellbauer (1980). This specification is estimated using Spanish time-series covering the period 1964–1995, which includes quantities and prices for four consumption goods, that is to say, Virginia tobacco, black tobacco, cigars and, finally, other goods. Given the nature of the data used, namely, time-series, the empirical analysis of this parametric method includes an econometric procedure which implies testing for the presence of autocorrelation. Adopting the formulation which does not suffer from this econometric problem, we then test the theoretical hypotheses of homogeneity and symmetry, with these being imposed on the model if they are statistically accepted. When this is the case, we are then able to calculate the price elasticities, which, in turn, allow us to derive the optimal taxes.

The rest of the paper is organized as follows. Section 2 presents the theoretical framework, including the formulation of the demand system incorporating addiction. The data and the estimation procedure are described in Section 3. Section 4 is devoted to the results of the analysis and, finally, Section 5 closes the paper with the most relevant conclusions.

2. Theoretical framework

The fundamental argument used to justify the use of special taxes on the part of governments to reduce the consumption of tobacco is the correction of the social

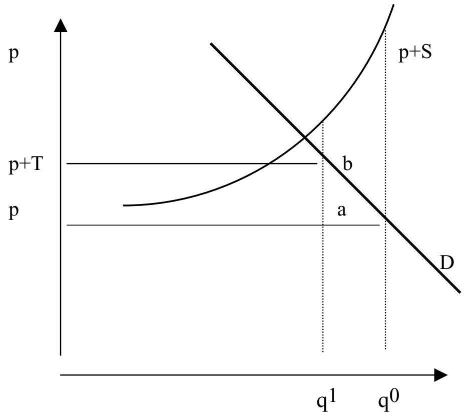

Fig. 1. Effects of a tax rate on welfare.

costs generated by that consumption. Assuming that this must be the objective criterion used to determine the optimal tax rates, we base our study on the theoretical model developed by Pogue and Sgontz (1989), supposing that the effect of a tax per unit of good is equivalent to an increase in the price of that good in an amount equal to the tax rate. Thus, the levying of a tax on tobacco consumption has two opposite effects on social welfare. First, it reduces the consumer surplus of smokers, given that these consume a lower number of packets and, at the same time, must to pay a higher price for each packet. By contrast, the reduction in consumption decreases the social costs that smokers impose on society, e.g., lost days at work and medical costs. Both these effects can easily be observed from Fig. 1, where we assume that the social costs S can be represented using an exponential curve. Thus, the smoker reduces his consumer surplus in an amount equal to area a. On the other hand, society benefits from the reduction in tobacco consumption $(q^0 - q^1)$, which implies an increase in the welfare indicator equal to area $a + b$. Therefore, the levying of the tax rate T implies a net welfare benefit for society equal to area b.

The joint consideration of both these effects for the tobacco goods allows us to express the variation in the social welfare function in terms, amongst other variables, of the tax rates corresponding to the three types of tobacco. Subsequently, the optimization of social welfare with respect to the tax rates will determine the expressions that define the optimal tax for each of the goods, with such a tax being in function of the social costs and price elasticities.

On the basis of the above, we can formally express the welfare variation derived from taxation on the three different types of tobacco as:

$$\Delta W = \sum_{i}^{3} \left(-S_i \Delta q_i N_i + \frac{1}{2} T_i \Delta q_i N_i \right) \qquad (1)$$

where ΔW is the welfare variation, i is the subindex indicating the type of tobacco, that is to say, Virginia, black or cigars, S_i is the social costs per packet or cigar, Δq_i is the change in the number of packets or cigars demanded by a representative consumer, with this being given by the change in the tax rate per packet or cigar, N_i is the number of smokers of the ith type of tobacco and, finally, T_i is the tax rate per packet or cigar.

However, given that a change in the tax rate levied on a particular type of tobacco will modify the price and, therefore, the quantity demanded of the other two types of tobacco, we have:

$$\begin{aligned}\Delta q_i N_i &= \left(\frac{\partial q_i}{\partial p_1}T_1 + \frac{\partial q_i}{\partial p_2}T_2 + \frac{\partial q_i}{\partial p_3}T_3\right)N_i \\ &= q_i N_i e_{i1}\left(\frac{T_1}{p_1}\right) + q_i N_i e_{i2}\left(\frac{T_2}{p_2}\right) + q_i N_i e_{i3}\left(\frac{T_3}{p_3}\right) \\ &= \sum_j^3 q_i N_i e_{ij}\left(\frac{T_j}{p_j}\right) \qquad (2)\end{aligned}$$

with e_{ij} being the price elasticities. Substituting this expression in the welfare variation:

$$\Delta W = \sum_i^3 \left(-S_i \sum_j^3 q_i N_i e_{ij}\left(\frac{T_j}{p_j}\right) + \frac{1}{2}\sum_j^3 T_i q_i N_i e_{ij}\left(\frac{T_j}{p_j}\right)\right) \qquad (3)$$

and optimizing with respect to the tax rates, we derive the expression of the optimal tax rate for each type of tobacco:

$$T_i = \frac{\sum_j^3 S_j q_j N_j e_{ji}}{q_i N_i e_{ii}} - \frac{1}{2}\frac{\sum_{j\neq i} e_{ji} q_j N_j T_j + \sum_{j\neq i} e_{ij} q_i N_i (T_j p_i / p_j)}{q_i N_i e_{ii}} \qquad (4)$$

Therefore, in order to obtain the optimal tax rates, we need to calculate the price elasticities on the basis of a demand model that is consistent with the utility maximization hypothesis. In this line, we formulate the LAIDS, which is derived from the following PIGLOG expenditure function $\log c(p, u) = (1-u)\log a(p) + u \log b(p)$, where $0 \leq u \leq 1$, and where the linear homogeneous functions $a(p)$ and $b(p)$ can be interpreted as the subsistence expenditure ($u = 0$) and that corresponding to the maximum satisfaction situation ($u = 1$), respectively. From Shephard's Lemma, $\partial c(p,u)/\partial p_i = h_i$, we can obtain the Hicksian demand function and, assuming that the consumer spends all his income, we can obtain the indirect utility function, which can be substituted in the Hicksian function, thus obtaining our four Marshallian demand equation in terms of the budget shares:

$$w_i = \alpha_i + \sum_j^4 \gamma_{ij} \log p_j + \beta_i \log\left(\frac{y}{P^*}\right)$$
$$(i,\ j = \text{Virginia tobacco, black tobacco, cigars and other goods}) \qquad (5)$$

where w_i is the budget share of a particular good with respect to the total expenditure, α_i, γ_{ij} and β_i are parameters and, finally, P^* is the Stone (1954) index, $\log P^* = \sum_j^4 w_j \log p_j$.

On the basis of this initial version of the model, our addictive specification of the model (ALAIDS) is:

$$w_i = \alpha_i + \sum_j^4 \gamma_{ij} \log p_j + \beta_i \log\left(\frac{y}{P^*}\right) + \sum_j^4 \sigma_{ij} \log \mathrm{SA}_j$$
$$(i,\ j = \text{Virginia tobacco, black tobacco, cigars and other goods}) \quad (6)$$

where σ_{ij} are parameters and SA_j is the stock of addiction corresponding to the jth good.

After imposing the adding-up condition, $\sum_i^4 w_i = 1$, demand theory imposes several other restrictions on the parameters of the model, mainly homogeneity, $\sum_j^4 \gamma_{ij} = 0$, and symmetry, $\gamma_{ij} = \gamma_{ji}$.

Finally, the expressions of expenditure and price elasticities are $e_i = 1 + (\beta_i/w_i)$, and $e_{ij} = -\delta_{ij} + (\gamma_{ij}/w_i) - (\beta_i w_j/w_i)$, respectively, where δ_{ij} is the Kronecker delta ($\delta_{ij} = 1$, if $i = j$; $\delta_{ij} = 0$, if $i \neq j$).

3. Data and estimation

As a consequence of the above, the empirical application of the theoretical model requires, first, a knowledge of the social costs generated by the consumption of tobacco and, secondly, the calculation of the elasticities of the three types of tobacco being considered. With respect to the social costs, we use the figures presented in González, Barber, and Rodríguez (1997) for the Spanish economy, which have been obtained taking into account both the direct and indirect costs. Amongst the first, these authors include spending on health care, that is to say, expenditure on medicines and primary and specialized health care, both in hospital and outside, and also compute the cost savings in health care derived from early mortality. Within the group of indirect costs, they include social security payments for widows and widowers, orphans and invalidity, whilst they also deduce the savings in retirement pensions caused by early mortality imputable to tobacco consumption.

The necessary data for estimating the ALAIDS have been obtained from a variety of sources published by The Spanish State Tobacco Company (Tabacalera S.A.) and the National Accounts (OECD), and take the form of Spanish annual time-series covering the period 1964–1995 on consumption and prices for the following categories: (1) cigarettes made from Virginia tobacco, (2) cigarettes made from black tobacco, (3) cigars and, finally, (4) other goods. Table 1 provides a brief budget shares analysis of tobacco goods, with the average shares and different values being calculated along the whole sample period. We can observe that the

Table 1
Budget shares (%)

Good	1964	1970	1975	1980	1985	1990	1995	Mean
Virginia tobacco	14.78	14.68	22.34	43.65	62.92	69.22	70.86	41.78
Black tobacco	74.17	74.09	65.22	43.42	28.66	23.57	23.84	48.03
Cigars	11.04	11.22	12.43	12.91	8.41	7.20	5.28	10.17

highest mean budget share corresponds to black tobacco, 48.03%, whereas the lowest appears in the cigars group, 10.17%. We can also note the decreasing time evolution of the budget shares of black tobacco and, by contrast, the increasing trends of Virginia tobacco values.

With respect to the empirical application, we begin from the stochastic formulation of the addictive demand model, obtained by adding an error term to every equation that captures taste shifts, measurement errors in the dependent variable and the effects of left out variables. Moreover, given the time horizon, we think it is interesting for the model to take account of the impact of Government regulatory changes on tobacco consumption by way of dummy variables. In particular, we include several new variables. The first, T_{78} (=0 until 1977, =1 from 1978), is derived from a regulation which limits tobacco advertising. The second, T_{79} (=0 until 1978, =time trend from 1979), incorporates improvements in the quality and presentation of the good. Finally, the third and fourth variables, T_{82} (=0 until 1981, =1 from 1982) and T_{88} (=0 until 1987, =1 from 1988), establish restrictions on the sale and consumption of tobacco. Thus, the resulting stochastic demand function is:

$$\begin{aligned} w_{it} &= \alpha_i + \sum_j^4 \gamma_{ij} \log p_{jt} + \beta_i \log\left(\frac{y_t}{P_t^*}\right) + \sum_j^4 \sigma_{ij} \log \mathrm{SA}_{jt} + \tau_{78} T_{78} \\ &\quad + \tau_{79} T_{79} + \tau_{82} T_{82} + \tau_{88} T_{88} + u_{it} \\ &\quad (i,\ j = \text{Virginia tobacco, black tobacco, cigars and other goods}) \end{aligned} \tag{7}$$

The adding-up restriction implies that $\sum_i^4 u_{it} = 0$ and, therefore, the covariance matrix is singular and the likelihood function undefined. In this situation, the usual procedure is to drop one of the equations, estimate the remaining system and calculate the parameters in the omitted equation via the adding-up condition. Moreover, given the habitual assumptions of error terms contemporaneously correlated but serially uncorrelated, the model is jointly estimated by using the SURE method of Zellner (1962), which provides efficient estimations. After formulating the model in its stochastic terms, we must test for the presence of joint autocorrelation by means of a diagnostic statistic which recognizes the adding-up condition and, hence, allows us to consider the system globally. In particular, we use the test proposed by Harvey (1982), which is asymptotically distributed as a chi-square variable with degrees of freedom equal to the number of equations being estimated.

Once we have shown that the stochastic model does not exhibit autocorrelation problems, we must test the theoretical hypotheses and, if these are accepted, then they will be imposed on the specification of the model. In order to do this, we employ the corrected Wald test, obtained as the product of the initial Wald test and a correction factor. The use of this corrected test is justified given the bias of the initial test towards the rejection of the null hypothesis. Moreover, in this case we use the factor proposed by Mauleon (1984), $CF = (1 - n/T)(1 - k/T)$, where n is the number of estimated equations, k the average number of parameters per equation and, finally, T the sample size. The corrected Wald test is asymptotically distributed as a chi-square variable with degrees of freedom equal to the number of restrictions being tested.

4. Empirical results

The empirical results are first obtained from the estimation of the addictive demand model. We estimate the initial model, deriving a value of the Harvey test, 6.32, lower than the critical value at the 5% level of significance, $\chi^2(3)_{0.05} = 7.81$. Thus, this model does not exhibit autocorrelation problems and, therefore, we can check the theoretical conditions of homogeneity and symmetry by means of the corrected Wald test. These values, 2.68 for homogeneity and 9.87 for joint homogeneity and symmetry, are lower than the critical values at the 5% level of significance, $\chi^2(3)_{0.05} = 7.81$ and $\chi^2(6)_{0.05} = 12.59$, and, hence, we can conclude that this formulation satisfies the theoretical properties derived from demand theory. Imposing these properties, we obtain the restricted version of the model, which is again estimated and checked for the presence of autocorrelation. We can also note that the new restricted version does not present this econometric problem, given that the value of the Harvey test, 5.91, is also lower than the critical value at the 5% level of significance. In conclusion, the homogeneous and symmetric version of the model satisfies the econometric and theoretical requirements and, hence, can be used for the purpose of representing the demand behavior of Spanish smokers from 1964 to 1995 (Table 2).

Having chosen one particular model, Table 3 shows the estimated parameters and the degree of fit. As regards the individual significance of the coefficients, we can observe that the majority of the estimated parameters are significant at 5%. With respect to the addiction coefficients which measure the effect of consumption habits, we can note that two of the three parameters per equation, specifically,

Table 2
Theoretical hypotheses tests

Hypotheses	Corrected Wald
Homogeneity	2.68
Homogeneity and symmetry	9.87

Table 3
Estimated parameters

Good	α_i	γ_{i1}	γ_{i2}	γ_{i3}	β_i	σ_{i1}	σ_{i2}
Virginia tobacco	.0422[a] (4.53)	.0025[a] (3.95)	.0012 (1.17)	−.0017[a] (−3.81)	−.0038[a] (−3.68)	.0048[a] (10.5)	−.0011 (−.95)
Black tobacco	.0243[a] (2.86)	.0035[a] (6.42)	.0025[a] (3.95)	.0016[a] (4.50)	−.0022[a] (−2.42)	−.0012[a] (−2.83)	.0030[a] (2.83)
Cigars	.0072 (1.12)	.0016[a] (4.50)	−.0017[a] (−3.81)	.0001 (.24)	−.0004 (−.61)	.0019[a] (2.52)	.0003 (.98)

Good	σ_{i3}	T_{78}	T_{79}	T_{82}	T_{88}	R^2
Virginia tobacco	−.0019[a] (−2.52)	−0.0003 (−1.58)	0.0001 (0.93)	0.0005[a] (2.91)	−0.0002 (−1.20)	.99
Black tobacco	−.0008 (−1.35)	−0.0003 (−1.58)	0.0001 (0.93)	0.0005[a] (2.91)	−0.0002 (−1.20)	.99
Cigars	−.0011[a] (−1.97)	−0.0003 (−1.58)	0.0001 (0.93)	0.0005[a] (2.91)	−0.0002 (−1.20)	.89

t values in parentheses.
[a] Significant at the 5% level.

Table 4
Mean elasticities

Good	e_i	e_{i1}	e_{i2}	e_{i3}
Virginia tobacco	0.3736[a] (2.19)	−0.8027[a] (−4.88)	0.4192[a] (3.98)	−0.2879[a] (−3.80)
Black tobacco	0.6737[a] (5.00)	0.3695[a] (3.98)	−0.4796[a] (−5.91)	0.2324[a] (4.51)
Cigars	0.6969[a] (2.42)	−1.2211[a] (−3.82)	1.1110[a] (4.50)	−0.9319[a] (−3.32)

t values in parentheses.
[a] Significant at the 5% level.

the direct coefficients, are individually significant at the 5% level. Moreover, the parameter of the dummy variable T_{82} also satisfies this property of statistical significance. Despite the fact that R^2 is only an approximate indicator of the fit in the demand system, and thus has to be carefully interpreted, we find, as is usually the case, that the model appears to fit well. This is illustrated by the very high coefficients, where all values appear between .89 and .99. These results again confirm that the chosen addictive specification adequately represents the consumer behavior of Spanish smokers during the period under study.

Table 4 shows the values of the expenditure and price elasticities calculated at the mean point of the explanatory variables. We can first observe that the three expenditure elasticities are individually significant at the 5% level. The particular values indicate that all tobacco goods are necessities, with cigars exhibiting the highest mean effect, 0.69, and with Virginia tobacco showing the lowest, 0.37. All the Marshallian own-price elasticities are negative, as theory predicts for decreasing demands, with the three effects being statistically significant at the 5% level. The values, in absolute terms, are between the highest, corresponding to cigars, −0.93, and the lowest, that of black tobacco, −0.47, with all three elasticities indicating inelastic demands. With respect to the cross-price effects, we can first note that all values are individually significant at the 5% level, obtaining the same sign in all the symmetric pairs, with a positive sign, characteristic of substitute goods, for the pairs Virginia tobacco–black tobacco and black tobacco–cigars, and with a negative sign indicating complementary goods for the pair Virginia tobacco–cigars.

With respect to the evolution of the expenditure and price elasticities, in Table 5 we can observe a decreasing trend in the expenditure effects of black tobacco and cigars, whereas the trend is increasing for the elasticity of Virginia tobacco. As regards the own-price elasticities, the absolute terms corresponding to Virginia tobacco increase from the beginning of the sample until the end, whereas the values of black tobacco and cigars decrease during almost all the period.

We can now compare the values of our estimated elasticities with those of other studies devoted to analyzing the demand for tobacco. In this regard, the review of the literature by Lewit and Coate (1982) for a number of Western countries indicates that the price elasticity lies between −0.4 and −1.3. However, more recent reviews indicate narrower ranges of variations. Thus, Harris (1987) finds values of between −0.4 and −0.5, whilst Keeler, Hu, Manning, and Sung (2001) shows values from −0.2 to −0.7, and Chaloupka and Wechsler (1997) of between −0.3 and −0.5.

Table 5
Evolution of elasticities

Good	1964	1970	1975	1980	1985	1990	1995
Virginia tobacco							
e_i	−0.64	−0.56	−0.31	0.22	0.62	0.62	0.69
e_{i1}	−0.49	−0.51	−0.59	−0.75	−0.88	−0.88	−0.90
e_{i2}	1.11	1.06	0.88	0.52	0.25	0.25	0.21
e_{i3}	−0.76	−0.72	−0.60	−0.36	−0.18	−0.17	−0.14
Black tobacco							
e_i	0.81	0.82	0.74	0.54	0.51	0.35	0.45
e_{i1}	0.22	0.21	0.30	0.52	0.56	0.74	0.62
e_{i2}	−0.69	−0.71	−0.58	−0.26	−0.22	0.04	−0.13
e_{i3}	0.14	0.13	0.19	0.33	0.35	0.47	0.39
Cigars							
e_i	0.75	0.77	0.73	0.70	0.67	0.58	0.52
e_{i1}	−1.01	−0.94	−1.08	−1.22	−1.31	−1.66	−1.93
e_{i2}	0.92	0.86	0.98	1.11	1.19	1.52	1.76
e_{i3}	−0.94	−0.95	−0.94	−0.93	−0.93	−0.91	−0.89

Note, therefore, that our values are slightly higher than those reported earlier. This a result which is coherent with demand theory if we taken into account that all these international studies have only considered one tobacco good. However, our consideration of three types of tobacco implies that these differentiating categories will respond with greater intensity to prices, that is to say, they will have higher price elasticities.

Table 6 shows the optimal taxes and social costs, as well as the percentage difference. We can first note the small differences, in absolute values, in all three cases, with the highest corresponding to Virginia tobacco, −2.77%, and with the

Table 6
Optimal taxes and social costs

Good	1964	1970	1975	1980	1985	1990	1995	Mean
Virginia tobacco								
Optimal tax	1.71	2.40	4.29	10.40	18.06	24.81	32.56	12.66
Social cost	1.82	2.63	4.65	10.27	18.07	24.85	32.61	12.73
Difference (%)	−6.04	−8.75	−7.74	1.27	−0.06	−0.16	−0.15	−2.77
Black tobacco								
Optimal tax	1.81	2.61	4.61	10.28	18.07	24.83	32.55	12.70
Social cost	1.82	2.63	4.65	10.27	18.07	24.85	32.61	12.73
Difference (%)	−0.55	−0.76	−0.86	0.10	0.00	−0.08	−0.18	−0.51
Cigars								
Optimal tax	0.49	0.71	1.22	2.52	4.51	6.21	8.13	3.17
Social cost	0.46	0.66	1.16	2.57	4.52	6.21	8.15	3.18
Difference (%)	6.52	7.58	5.17	−1.95	−0.22	0.00	−0.25	1.13

lowest, corresponding to black tobacco, being almost null, −0.51%. As regards the time evolution, we can observe decreasing trends in all three tobacco goods. Thus, although in the first decade we can note a slight increase in the difference between the optimal tax and the social costs, from 1975 onwards the optimal tax approximates the external cost, with the difference in the final years of the sample being lower than 1%.

As regards the policy implications that can be derived from our paper, we have found that policy makers could correct the social costs of tobacco consumption by levying optimal taxes that are equal to these costs. However, although this criterion is apparently very simple, its application is not so straightforward, with the main difficulty appearing in the determination of the social costs. First, there is no unique definition of social costs. Moreover, even after agreeing the items which constitute them, their evaluation is very complex, given that this requires that we previously specify a number of assumptions. Finally, there are complementary factors in the generation of these costs, for example, the consumption of alcohol, that makes it difficult to allocate the total costs to each factor. In the light of all this, determining the social costs requires that we make a large number of assumptions and prior decisions and, therefore, implies a significant arbitrary component.

Despite this problem, the results of the model can be used in order to derive some guidelines when designing a fiscal policy aimed at correcting the social costs generated by tobacco consumption. Thus, the optimal tax should be determined according to the social costs and, therefore, should be independent of the sale price. However, this is not the case in Spain, where the special tax is made up of two components, one specific and the other proportional, with the higher percentage corresponding to this second component. This implies that, given two packets of cigarettes that generate identical social costs, the more expensive packet will be taxed at a higher rate. This would not appear to be reasonable if we consider that, after the application of the general VAT which guarantees the principle of horizontal equity, the additional tax should only contemplate the social costs generated by tobacco consumption. Thus, bearing in mind that these social costs depend on the number of cigarettes consumed, and not on their price, two packets that generate identical social costs should pay the same amount, independent of their price. From this point of view, it seems to be more appropriate to use a constant rate of tax per unit consumed.

Furthermore, a more equitable special tax should properly reflect the content of harmful substances, such as nicotine or tar, with higher taxes being levied on cigarettes containing higher levels of these substances. Thus, a hypothetical knowledge of the individual contribution of each substance to the social costs should allow us to establish the tax in terms of these individual contributions and, although such an approach is not currently being applied in any country, at least to the best of our knowledge, it nevertheless appears to be an appropriate way of taxing tobacco consumption.

Finally, by way of comparison, we can consider a similar study, in this case for three alcoholic beverages, that has been carried out by Saffer and Chaloupka

(1994). By contrast with our study, these authors obtain worse fits between the optimal taxes and the social costs of every beverage. A possible explanation for this difference between their results and ours is that they assume that the three goods are substitutes, without estimating them. However, we have first estimated the character of the pairs. As a consequence, we have correctly obtained the effect of increasing taxes on consumption and, therefore, on the social costs generated by the good.

5. Summary and conclusions

In this paper, we have modeled the optimal fiscal policy on three types of tobacco, that is to say, on Virginia tobacco, black tobacco and cigars, as an instrument for controlling the social costs generated by their consumption. To that end, we have obtained the individual optimal taxes from the price elasticities from ALAIDS, which has been estimated using Spanish time-series from 1964 to 1995.

The empirical results show that the homogeneous and symmetric version of the ALAIDS satisfies the econometric and theoretical requirements and, hence, can be used for the purpose of representing the economic behavior of Spanish smokers during this period. Having chosen this particular model, the expenditure elasticities indicate that all tobacco goods are necessities, with cigars exhibiting the highest mean effect, and Virginia tobacco the lowest. All the Marshallian own-price elasticities are negative, as theory predicts for decreasing demands, with the three effects being statistically significant at the 5% level. With respect to the cross-price effects, we obtain a positive sign, characteristic of substitute goods, for the pairs Virginia tobacco–black tobacco and black tobacco–cigars, and a negative sign, indicating complementary goods, for the pair Virginia tobacco–cigars. The evolution of the elasticities shows a decreasing trend in the expenditure effects of black tobacco and cigars, whereas the trend is increasing for the elasticity of Virginia tobacco. As regards the own-price elasticities, the absolute terms corresponding to Virginia tobacco increase from the beginning of the sample until the end, whereas the values of black tobacco and cigars decrease throughout the length of the period.

Finally, our empirical results show small differences between the optimal taxes and the social costs for all three tobacco goods, with the highest corresponding to Virginia tobacco, −2.77%, and with the lowest, corresponding to black tobacco, being almost null, −0.51. As regards the time evolution, we have found decreasing trends in the difference of the three goods. In conclusion, when seeking to reduce tobacco consumption, Spanish policy makers should fit the optimal taxes to the social costs generated by that consumption.

References

Barlett, L. (1988). Smoking: We cannot afford the cost. *Canadian Medical Association Journal*, *3*, 297–312.

Becker, G. S., Grossman, M., & Murphy, K. M. (1994). An empirical analysis of cigarette addiction. *The American Economic Review*, *84*, 396–418.

Chaloupka, F. (1991). Rational addictive behavior and cigarette smoking. *Journal of Political Economy*, *99*, 722–742.

Chaloupka, F., & Wechsler, H. (1997). Price, tobacco control policies, and youth smoking. *Journal of Health Economics*, *16*, 359–373.

Deaton, A. S., & Muellbauer, J. (1980). An almost ideal demand system. *The American Economic Review*, *70*, 312–326.

Escario, J. J., & Molina, J. A. (2001). Testing for the rational addiction hypothesis in Spanish tobacco consumption. *Applied Economics Letters*, *8*, 211–215.

González B., Barber, P., & Rodríguez, E. (1997). El Tabaco: ?‘Un Caso de Externalidades Financieras en España. In *Análisis Económico de los Estilos de Vida: Externalidades y Coste Social*. Madrid: Civitas.

Harris, B. (1987). The 1983 increase in the Federal Cigarette Excise Tax. In L. H. Summers (Ed.), *Tax policy and the economy*. Cambridge: NBER and MIT Press.

Harvey A. (1982). *A test of misspecification for systems of equations* (London School of Economics Discussion Paper No. 31). London.

Keeler, T. E., Hu, T., Manning, W. G., & Sung, H. (2001). State tobacco taxation, education and smoking controlling for the effects of omitted variables. *National Tax Journal*, *54*, 83–102.

Lewit, E. M., & Coate, D. (1982). The potential for using excise taxes to reduce smoking. *Journal of Health Economics*, *1*, 121–145.

Mackenzie, T. D., Bartechi, C. E., & Schrier, R. W. (1994). The human cost of tobacco. *The New England Journal of Medicine*, *330*, 975–980.

Manning, W. G., Keeler, E. B., Newhouse, J. P., Sloss, E. M., & Wasserman, J. (1989). The taxes of sin: Do smoker and drinkers pay their way? *Journal of American Medical Association*, *11*, 1604–1609.

Mauleon, I. (1984). *Algunos Factores de Corrección para Contrastes Econométricos*. Madrid: Servicio de Estudios, Banco de España.

Pogue, T., & Sgontz, L. (1989). Taxing to control social costs: The case of alcohol. *The American Economic Review*, *79*, 35–43.

Saffer, H., & Chaloupka, F. (1994). Alcohol tax equalization and social costs. *Eastern Economic Journal*, *20*, 33–43.

Stone, R. (1954). Linear expenditure systems and demand analysis: An application to the pattern of British demand. *The Economic Journal*, *64*, 511–527.

Zellner, A. (1962). An efficient method of estimating seemingly unrelated regressions and tests of aggregation bias. *Journal of the American Statistical Association*, *57*, 348–368.