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Price elasticity of demand for cigarettes and alcohol in Ecuador, based on household data*

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ABSTRACT

Objective. *Estimate price elasticity of demand for cigarettes and alcohol in Ecuador using cross-sectional data from the National Survey of Urban and Rural Household Income and Expenditures (ENIGHUR, Spanish acronym) 2011-2012.*

Methods. *ENIGHUR 2011-2012 data were used with Deaton's (1, 2) methodology to estimate price elasticity of demand for cigarettes and alcohol with expenditure and quantity information. Household socioeconomic variables were also included.*

Results. *Price elasticity of demand for cigarettes is -0.87, meaning that a 10% price increase could lead to an 8.7% decrease in consumption. Results for cross-price elasticities of alcohol on cigarette demand are negative, as expected, indicating that they are complementary goods; however, the results are not statistically significant. Furthermore, it was found that price elasticity of demand for alcohol is -0.44, meaning that a 10% increase in the price of alcohol would produce a 4.4% decrease in consumption.*

Conclusions. *A policy of price increases—for example, through a tax increase—applied to both cigarettes and alcohol could have a positive effect on public health through reductions in consumption of both goods. However, this measure would not be sufficient to bridge gaps in prevalence measures and health outcomes between sex and other population groups, given the observed difference in the sensitivity of consumption to price variations.*

Key words: Health economics; tobacco use; elasticity; Ecuador.

Between 2000 and 2012, an increase in deaths from noncommunicable diseases was observed worldwide (3). High-income countries reported the smallest increase, from 85.6% to 86.8%, while in middle-income and low-income countries, the figure jumped from 52.3% to 62.5%. According to studies by the World Health Organization (WHO) (4), poverty is closely linked with noncommunicable diseases, with greater pressure on the limited health expenditures of poor households than on those of households that are better off. Tobacco use is also considered responsible for six million deaths each year (4), a figure projected to reach eight million by 2030. It has been determined (5) that the risk factors for noncommunicable diseases include: insufficient physical activity, unhealthy diet, alcohol consumption, and tobacco use. One of the most important measures for combatting these harmful behaviors worldwide has been the WHO Framework Convention on Tobacco Control (WHO FCTC), published in 2003, which stresses the importance of strategies to reduce the demand for tobacco products.

Between 2000 and 2012, a reduction in the lifetime prevalence of smoking was observed, falling from 11% to 7% in women and from 44% to 36% in men (3). The best performance was seen in high-income countries, which saw an 8.7% reduction in the male population, while in middle- and low-income countries the figure was 7.4%. The gap in lifetime prevalence in the female population is similar, with high-income countries achieving a 4.7% reduction, and middle- and low-income countries, 3.3%.

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Ecuador signed the WHO FCTC in 2004 and ratified it in 2006. In 2012, an estimated 22.7% of the Ecuadorian population smoked cigarettes (6), while in the previous decade it was found that the lifetime prevalence was approximately 30% (7). Thus, in aggregate terms, an almost 8% reduction was observed in just 10 years. However, to appreciate these data, further disaggregation is needed. For example, in 2012, it was observed that cigarette consumption was four times higher in adult males than adult females (6). In young people, in contrast, the difference was only 4%, indicating a disparity in smoking among gender and age groups. This difference may be due to cultural, socioeconomic, or other factors. The lack of studies that could explain these differences is one of the problems that this article seeks to remedy.

In 1998, the estimated lifetime prevalence among students of either sex was 44.3% (8), while in 2005, it was 54.4% and in 2011, 27.8%. Moreover, it was found that deaths from noncommunicable diseases in Ecuador have mirrored the upward international trend, climbing from 59.8% in 2000 to 67% in 2012 (3). Between 2001 and 2011, there was an increase in mortality from tracheal, bronchial, and lung cancer, whose leading cause is smoking, with deaths from these cancers inching up from 8 to 11.5 per 1000 deaths (9).

International experience has recognized that raising the price of cigarettes—for example through higher taxes—is the most cost-effective measure for reducing smoking (10). It should be pointed out, however, that raising the price could also lead to greater use of tobacco substitutes such as marijuana, water pipes, and e-cigarettes. Another potential effect of higher cigarette prices is an increase in smuggling; however, the lack of data sources and the findings of several studies refute this (11).

Between 2007 and 2012, the cigarette excise tax in Ecuador was increased from 90% to 150% (*ad valorem,* tariff on merchandise) of the taxable amount of the reference sales price. Currently, an estimated 73% of the retail price of a pack of 20 cigarettes corresponds to taxes (specific and value-added) (12), which is above the regional average of 45%. This tax increase is expected to continue in 2016, since this has been the trend for the past two years (13). At the time of this writing, Ecuador's National Assembly was debating a tax reform that, among other things, would increase the tax on cigarettes by one cent per unit.

With a policy of steady price increases aimed at reducing smoking and large gaps in prevalence among different population groups, it is important to understand, both qualitatively and quantitatively, the changes in cigarette consumption in different population groups in the face of changing prices. These variations can be measured through price elasticity of demand for cigarettes—that is, the percentage response of cigarette consumption to a percentage change in the price of cigarettes.

It was found that price elasticity of cigarette consumption is approximately -0.4 in the developed countries and up to -0.8 in the developing countries (14). In Latin America, the value was between -0.25 and -0.45, even though it is primarily a developing region (15). One possible explanation is that the majority of studies in the region use econometric time-series models with aggregate data on cigarette consumption or sales and an average sales price. The following limitations have been noted with studies of this type: a) it is impossible to examine the response to the price by individual characteristics such as sex, age, or sociodemographic status; b) they use small temporal dimensions with small sample sizes, which affects the efficiency of the estimates; c) the number of control variables used is very small; and d) non-stationary or non-endogenous time series can lead to spurious regressions (10, 16).

In Ecuador, price elasticity of approximately -0.46 was estimated for cigarette consumption (17). This study used the time-series methodology mentioned above, which could explain the relatively low value in comparison with studies of developing countries, where elasticity is around -0.8. This article proposes an alternative to this type of estimate, using the methodology developed by Deaton (1, 2) to estimate price elasticity of demand for cigarettes in Ecuador.

MATERIALS AND METHODS

The data used in this study were taken from the National Survey of Urban and Rural Household Income and Expenditures (ENIGHUR) 2011-2012, conducted by Ecuador's National Institute of Statistics and Census (INEC) between April 2011 and March 2012. The objective of this survey (18) was to provide information on the amount, distribution, and structure of urban and rural household income and expenditures. It employed two-stage random sampling with urban and rural representativeness at the national, provincial, and local level in nine self-represented cities stratified by low, middle, and high sociodemographic levels. The survey universe is all inhabitants of the national territory, both urban and rural, who are at least 5 years of age. In total, there is information on 39 617 households, representing a total of 3 923 123 households at the national level. Table 1 shows the sociodemographic structure of the households.

ENIGHUR 2011-2012 gathered information on the monthly expenditures of each household and quantities purchased. With this information for an entire set of goods, including cigarettes and alcohol, the unit value was obtained (ratio of the expenditure on an item and the quantity purchased). To perform this calculation, a single unit of measure was necessary. This was no problem in the case of cigarettes, since everything was expressed in cigarette units. In the case of alcohol, however, a conversion was made to a uniform unit (19).

The unit value could be used as a proxy for the market price. However, there is a quality component, due to the consumer's control over his decision about the unit value of the good, in contrast to a market price, over which an individual consumer has no influence. Thus, there is the possibility of spontaneity bias if unit values are used to explain the demand for cigarettes. For example, if two people purchase the same number of cigarettes but one spends more than the other, the first person may have selected a higher-quality brand, which would be reflected in a higher price.

Deaton (1, 2) developed an econometric model that uses expenditure and quantity data from household surveys to estimate a system of demand equations that includes the estimation of price elasticity (and cross-price elasticity) of goods in a consumer basket. This methodology exploits the spatial variation in price through the use of the unit values of the goods, which are the total spending on a good, divided by the quantity of the good acquired.

Table 2 shows the sample used in the estimate, the average cigarette and

TABLE 1. Sociodemographic structure of Ecuadorian households according to the National Survey of Urban and Rural Household Income and Expenditures (ENIGHUR) 2011-2012 in a total population of 3 923 123 households

	Northern Region (%)	Coastal Region (%)	Central Region (%)	Southern Region (%)	Total country (%)
Total	32	46	11	11	100
Sex of head of household					
Male	32	46	11	11	76
Female	31	46	11	12	24
Area					
Urban	35	52	6	8	68
Rural	25	33	24	18	32
Education of head of household					
Primary or less	29	44	14	13	52
Secondary	34	50	8	8	31
Tertiary or higher	37	44	8	10	17
Size of household					
One or two people	32	43	13	12	25
Three or four people	33	46	11	10	42
Five or more	29	48	11	12	33
Perception of poverty					
Considers household poor	24	53	12	12	58
Considers household not poor	42	36	11	11	42
Ethnicity of head of household					
Mestizo	32	45	10	13	78
Indigenous	37	6	45	12	7
Other	29	66	3	3	15
Deciles of per capita expenditure					
Decile 1-3	27	43	17	13	30
Decile 4-7	30	50	10	10	40
Decile 8-10	38	43	8	11	30

alcohol expenditure, and the unit values of these goods for the national total and for a measurement of income level obtained from the classification of expenditure deciles, as shown in Table 1.

The methodology relates the unit values to certain sociodemographic characteristics—for example, total household expenditure as a proxy for income, education, sex of the head of household, etc. Thus, a cigarette demand function and unit value function can be proposed:

$$q_{ic} = \alpha_1 + \epsilon_x x_{ic} + \epsilon_p p_c + \epsilon_{l,z} z_{ic} + f_c + u_{l,ic} \quad (1)$$

$$v_{ic} = \alpha_2 + \beta_x x_{ic} + \square_p p_c + \epsilon_{2,z} z_{i,c} + u_{2,ic} \quad (2)$$

q_{ic} = quantity (proportion of total expenditure) for household *i*, in cluster *c*.

x_{ic}= total expenditure of household *i*, in cluster *c*.

p_c = price of the good (cigarettes or alcohol), which does not vary in cluster *c*.

z_{ic}= vector of sociodemographic characteristics of household *i*.

f_c = unobserved characteristics common to cluster *c* (fixed effect).

u1,*ic y u*2,*ic* = i.i.d. (independent and identically distributed) errors of every household *i* in cluster *c*.

Since the two functions are affected by the market price of cigarettes (*pc*), the price coefficient cannot be determined. However, the proposed methodology is based on exploiting the spatial variation between clusters that are easily identified by the surveys' sampling design. The assumption of spatial price variation between clusters is considered more plausible in developing countries, where transportation costs can heavily influence the end price of cigarettes—an assumption that could apply to Ecuador (2, 20).

For this study, the cluster used was the geopolitical division of parishes, which in other places are known as municipalities. In 2011, there were 900 parishes nationwide, 624 of which were included in the survey. The identification process consists of recognizing the possibility of consistently estimating all parameters other than price, as long as it is assumed that the price does not vary within each cluster (20). Thus, the price effect will be contained in the fixed effect of the cluster. This is a rather reasonable assumption, since a cluster is usually a specific geographic space defined by a certain characteristic—(21), for example, a town, community, parish, or canton, and the individuals within the cluster are faced with a single market, making it feasible to assume a single price within the cluster.

Elasticity is estimated in three steps (2, 22). First, equations 1 and 2 are estimated without the price, which is an unobserved variable, to obtain the average area-adjusted quantities. Second, a measurement error is estimated, correcting for measurement errors in the model's variables due to errors in the survey or in the report on the same household in the clusters. Third, the effect of quality and price is separated to obtain an estimate of own price elasticity and cross-price elasticity of demand for cigarettes and alcohol, corrected for the effects of quality and measurement errors of the variables.

RESULTS

Table 3 presents the results obtained from the application of Deaton's methodology, described in the previous section. The price elasticity of demand for cigarettes is statistically significant, has the expected sign, and its value is -0.87. This means that, given a 10% increase in price, for example, cigarette consumption would decrease by 8.7%.

The effect of the price of alcohol on the demand for cigarettes was not statistically significant. On the other hand, the price elasticity of demand for alcohol *was*, with the expected sign (-0.44); that is, the demand for alcohol is more inelastic than the demand for cigarettes. For example, if the price of alcohol were increased by 10%, consumption would fall by just 4.4%. For this good, its cross-price elasticity with respect to cigarettes was not statistically significant either, meaning that in this sample, nothing can be said about cross elasticities between the two goods.

This methodology makes it possible to identify two more elasticities that can be used to expand the analysis. These are the quality and quantity elasticities with respect to total expenditure, which are statistically significant and positive for both goods. This result implies that an increase in total expenditure (a proxy for income) would lead to

TABLE 2. Expenditure, quantity, and average unit values of the estimation sample of the National Survey of Urban and Rural Household Income and Expenditures (ENIGHUR) 2011-2012 for 9 849 households with positive expenditure on alcohol or cigarettes

Households with positive expenditure on alcohol or cigarettes	Low level		Medium level		High level		National total	
	22%		41%		37%		100%	
	US$	SD	US$	SD	US$	SD	US$	SD
Total household expenditure	507.52	214.8	802.53	346.7	1 532.48	1 025.2	1 007.67	789.8
Expenditure on cigarettes	3.41	7.3	4.53	9.5	7.02	14.1	5.21	11.1
Expenditure on alcohol	8.26	13.3	9.18	15.7	11.16	22.5	9.71	18.1
Unit value of cigarettes	0.63	0.2	0.65	0.2	0.66	0.2	0.65	0.2
Cluster 180160 [a]	Not applicable	Not applicable	0.86	0.0002	Not applicable	Not applicable	0.86	0.1
Cluster 190550	0.58	0.2	0.62	0.2	0.68	0.3	0.62	0.2
Cluster 200350	Not applicable	Not applicable	0.73	0.4	0.93	0.2	0.91	0.3
Unit value of alcohol (liter)	4.05	2.8	4.24	2.95	4.75	3.3	4.39	3.1
Cluster 180160 [a]	Not applicable	Not applicable	3.66	2.2	Not applicable	Not applicable	4.24	2.4
Cluster 190550	3.02	0.02	5.46	3.5	6.70	2.5	5.69	3.2
Cluster 200350	Not applicable	Not applicable	9.03	5.7	8.01	5.8	8.13	5.8
	Units	SD	Units	SD	Units	SD	Units	SD
Quantity of cigarettes	13.82	18.7	16.25	22.1	22.68	30.3	18.28	25.3
	Liters	SD	Liters	SD	Liters	SD	Liters	SD
Quantity of alcohol	4.40	6.4	4.43	6.0	4.63	6.5	4.50	6.3

[a] Three clusters were randomly selected to exemplify the assumption of non-variation within the cluster and among clusters.
US$=United States dollars; SD=standard deviation.

TABLE 3. Price elasticities of cigarettes and alcohol

Elasticity	Cigarettes		Alcohol	
	Value	SD	Value	SD
Quality with respect to expenditure	0.03 [b]	0.01	0.16 [a]	0.02
Quantity with respect to expenditure [a]	0.50	0.04	0.41	0.04
Own [a]	-0.87	0.23	-0.44	0.06
Cross	0.04	0.06	0.15	0.19

Note: Standard deviations are obtained through Bootstrap with 1 000 replicates.
[a] Significant to 99%.
[b] Significant to 95%.
Source: Author's own preparation.

an increase in consumption and the quality of the good selected, which is consistent. The elasticity of cigarette consumption with respect to total expenditure is 0.5, suggesting that a 10% increase in total expenditure would increase cigarette consumption by 5%. This is a proxy for income elasticity of demand for cigarettes. For alcohol, this value is 0.41, suggesting that a 10% increase in total expenditure would lead to a 4.1% increase in alcohol consumption. In contrast, the elasticity of a proxy for the quality of the cigarettes consumed with respect to total expenditure is 0.03, while that for alcohol is 0.16. This means that if total expenditure declined, the decision to consume higher-quality goods would also, in this case more so for alcohol than cigarettes.

Given the interest in examining the differences between population groups and the availability of information to do so, the procedure was applied by expenditure levels and the sex of the head of household to explore the differences in the response to price among different sociodemographic groups.[1] Table 4 shows that the price elasticity of demand for cigarettes and alcohol is not statistically significant at the low level of expenditure, while it is for the medium and high levels. At the middle- and high-expenditure levels, the response of the demand for cigarettes to their price is elastic. This result may be due to idiosyncrasies of the society. It would be ideal to have a larger representative sample of these households, so that more robust results could be generated in this regard.

The price elasticity of demand for alcohol in households with high levels of expenditure is more inelastic. However, if analyzed in terms of the sex of the head of household, it is impossible to identify a difference in price elasticity of demand for cigarettes, since the result is not significant for households headed by women. Notwithstanding, statistically significant results for alcohol *are* obtained in both population groups. Here, it is observed that for households headed by women, the price elasticity of demand for alcohol is greater than for households headed by men, indicating greater price sensitivity in these households.

Discussion and policy implications

The short-term price elasticity of demand for cigarettes found for Ecuador is almost double that found in similar studies in the region (15, 16). However, the value of -0.87 is consistent with the international literature for developing countries such as Ecuador. It is important to point out that the analysis and results presented are based on a cross section of data (2011-2012), meaning that it would

[1] This was also tested with other sociodemographic variables, such as the head of household's ethnicity, the region of residence, whether the subject perceived him- or herself as poor, and the size of the household. Statistically significant results were not obtained for any of these groups; it was therefore decided not to show them. These results are available from the author on request.

TABLE 4. Price elasticities of cigarettes and alcohol by expenditure level and sex of the head of household

Parameter	Cigarettes		Alcohol	
	Price elasticity	SD	Price elasticity	SD
Low level of expenditure	-0.25	29.81	0.21	3.91
Medium level of expenditure	-1.14[b]	0.49	-0.44[a]	0.14
High level of expenditure	-1.25[a]	0.3	-0.37[a]	0.06
Male head of household	-0.82[b]	0.4	-0.41[a]	0.07
Female head of household	-1.24	11.38	-0.53[a]	0.13

Note: Standard deviations are obtained through Bootstrap with 1 000 replicates.
DE= standard deviation.
[a] Significant to 99%.
[b] Significant to 95%.
[c] Significant to 90%.
Source: Author's own preparation.

be ideal to expand and replicate the study with data from similar available surveys of another type, with a view to estimating long-term elasticity, among other things, to supplement this analysis.

The differences observed could also be due to the type of data used in other studies (23), which use aggregate data and time-series methodologies, while this study uses data from household surveys. These data offer an opportunity to obtain results that indicate the behavior of each household while facilitating a deeper and more detailed understanding of the differences observed between population groups in terms of the prevalence of smoking or alcoholism.

From the results obtained, the differences between groups can be analyzed by the level of total household expenditure (a proxy for income). The high-level expenditure group would be more sensitive to variations in the price of cigarettes. This conclusion is in contrast to that of other studies (24), which argue that the poorest groups are more sensitive to price variations, meaning that an increase in the tax on cigarettes would be progressive. The results of this study, however, indicate that the low-expenditure group would not be as responsive to changes in prices. Furthermore, it could be concluded that, if their consumption is high relative to that of the rest of the population, as mentioned in other studies (14, 24), their share of cigarette tax revenues would be high, which reflects the regressivity of the tax. Thus, it would be very important to supplement an active policy of price increases with other policies to effectively discourage consumption in the low-income population.

Understanding the differences in the behavior of the different population groups is very important for developing comprehensive strategies that reduce cigarette consumption across the board in all population groups or that are focused on the most vulnerable groups. Thus, an increase in cigarette prices could be accompanied by policies that have also proven cost-effective (10, 24), such as 100% smoke-free environments, apply effective health warnings about the dangers of tobacco, and enforce bans on tobacco advertising, promotion and sponsorship. Together, these measures could bridge the inequality gaps in smoking prevalence and, thus, inequality in public health outcomes.

This study is a first step toward developing a better understanding of the effectiveness of smoking prevention policies—in particular, the effect of a price increase on the different population groups. It shows that using the available household surveys in Ecuador allows a better understanding of public policies. It is essential to introduce comparisons between population groups into the analysis to improve public policy-making, identifying which policies work best for each group to prevent a significant gap in prevalence or public health outcomes. The application of econometric methodologies to household survey data is the best option for this type of analysis.

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Elasticidad precio de la demanda de cigarrillos y alcohol en ecuador con datos de hogares

RESUMEN

Objetivo. Estimar la elasticidad precio de la demanda de cigarrillos y alcohol en Ecuador mediante la utilización de datos de corte transversal de la Encuesta Nacional de Ingresos y Gastos de Hogares Urbanos y Rurales (ENIGHUR) 2011-2012.

Métodos. Se utilizaron datos de la ENIGHUR 2011-2012. Se aplicó la metodología desarrollada por Deaton (1, 2) para estimar la elasticidad precio de la demanda de cigarrillos y alcohol con información sobre gasto y cantidades. Además, se incluyeron variables socioeconómicas de los hogares.

Resultados. La elasticidad precio de la demanda de cigarrillos es de 0,87. Esto significa que, si los precios se incrementaran 10%, el consumo podría disminuir 8,7%. Los resultados de elasticidades precio cruzadas del alcohol sobre la demanda de cigarrillos muestran el signo esperado, es decir negativo, lo que indicaría que son bienes complementarios; sin embargo, no son significativos desde el punto de vista estadístico. Además, se halló que la lasticidad precio de la demanda de alcohol es –0,44, por lo que un incremento de 10% en el precio del alcohol generaría una reducción en su consumo de 4,4%.

Conclusiones. Una política de incremento de precios, por ejemplo, con un alza de impuestos aplicada tanto a los cigarrillos como al alcohol, podría tener un efecto positivo sobre la salud pública mediante la disminución del consumo de ambos bienes. Sin embargo, esta medida no sería suficiente para reducir las brechas en las medidas de prevalencia y resultados de salud entre género y otros grupos poblacionales, dada la diferencia observada en la sensibilidad del consumo a variaciones del precio.

Palabras clave Economía de la salud; uso de tabaco; elasticidad; Ecuador.