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Using Compensating Variation to Measure the Costs of Taxing Cigarette in Iran

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Abstract

Background: The impact of pricing strategies on different socioeconomic groups is not uniform. There is urgency in addressing of characteristics of household demand to make a policy choice in line with development goals.
Objectives: This study was done to assess the effect of welfare loss from counterfactual tax-induced cigarette price increases on representative smokers by different expenditure quintiles in Iran.
Methods: This analytical study was conducted using pooling cross-sections and compensating variation (CV) to evaluate the costs of taxing cigarettes. The data source used in our study was the Household Income and Expenditure survey (HIES) from 2001 - 2017. We did an almost ideal demand system (AIDS) analysis to estimate elasticities for cigarette demand and compute welfare losses from simulated cigarette price increases by socioeconomic groups. We used STATA version 15.1 (StataCorp, College Station, TX, USA), and Microsoft Excel 2016 to undertake the relevant analyses and estimates.
Results: The highest loss was suffered by households of the poorest quintile, who should afford 1.41%, 2.47%, and 3.20% more budget in the long-run, respectively, as the result of three simulated price increases to stay at the same well-being as before.
Conclusions: Concerning direct welfare loss from the cigarette taxation reform in Iran, and focusing on low-income groups, such a policy can be considered as regressive. However, this regressivity can be reduced by informing strategies to redirect sin tax revenues that benefit the poor.

Keywords: Taxation, Cigarette, Welfare Loss, Iran

1. Background

Tobacco use is extensively acknowledged to be causally linked to suffering communicable and noncommunicable diseases (NCDs) (1, 2). Globally, tobacco is responsible for 14% of all adult deaths from NCDs, and 5% of all deaths from communicable diseases among people aged 30 years and older (3). Worldwide, about 21% or just over 1.4 billion people aged $\geq$ 15 years smoked tobacco in 2007 - 2017, showing a relative decrease in the global average of smoking rates through 10 years (4). The projections of declining global trends in tobacco consumption elucidate that most countries will not attain the target of a 30% reduction in adult smoking prevalence by 2025 based on 2010 levels set by the World Health Organization (WHO), unless strong tobacco control measures are implemented (4). Taxation is among the measures taken to reduce the overconsumption of "sin goods," such as cigarettes that create externalities in the form of cost of diseases and pollution to society. However, a decisive objection against "sin taxes" is the disproportionate burden that they impose on less-resourced consumers (5). One of the most frequently used methods to assess the consequence of pricing policy on family welfare is to appreciate monetary measures of welfare changes, the compensating variation (CV). The CV is defined as expenditure required to satisfy the original level of utility in terms of the price changes (6). Tax rates in Iran comprise a small proportion of cigarette prices; the WHO recommends that tobacco taxes should be at least 70% of the retail price (7). By relying on published literature, no research has investigated the welfare consequences of cigarette taxation in Iran. Since the poorer households are particularly vulnerable to cigarette inflation, studying the impact of taxing

cigarette -the commonly-used form of tobacco- on the welfare of poorer smokers might lead to valuable policy implications. This study is the first one conducted to offer quantitative evidence to inform decisions about cigarette taxation. The aim of the current study was to calculate the CV for increased cigarette prices and to explore how this measure is changed concerning changes in cigarette price among expenditure quintiles. Quantifying the impact of cigarette price increase on smoker welfare provides policymakers an opportunity to stabilize the welfare of households who are more vulnerable by recycling a part of tax revenues on programs that benefit them. Iranian policymakers must focus their efforts on raising the price of cigarettes while compensating for the welfare loss of the poorest sections of the population.

2. Objectives

We analyzed the costs that are imposed directly on the families with a smoker(s) rather than estimating all the costs of smoking, such as the direct, indirect and intangible aspects incurred by treating smoking-related diseases to households and the public sector.

3. Methods

The current study was a retrospective, analytical, and observational survey. The data source used in our study was the Household Income and Expenditure survey (HIES) from 2001 - 2017. The HIES is administered by the Statistical Center of Iran (SCI) and is the representative at the national level. The SCI selects sample households based on a 3-stage stratified sampling method. In the first step, sample cities, referred to as strata, are selected based on certain criteria from all provinces nationwide. Then, within the selected cities, residential districts are delimited and drawn using systematic sampling. Finally, sample households are randomly selected from each residential district. Household data are compiled by interviews, registration, and observation. Data on income and expenditure of the sample households are recorded by an interviewer through the household budget survey questionnaire. Interviewed individuals are often the head of the household or other members aged 15 years and over. The datasets and questionnaires for the 2001 to 2017 SCI surveys are available at https://www.amar.org.ir/default.aspx. The sample size is determined each year by the SCI, and data on socioeconomic indicators are obtained using a nationally representative sample of households. Generally, sample sizes of 30000 or larger are selected from the entire population of Iran annually. A total of 577,766 sample households from 2001 to 2017 were included for analysis in our study. We used STATA version 15.1 (StataCorp, College Station, TX, USA) and Microsoft Excel 2016 to undertake the relevant analyses and estimates.

3.1. Cigarette Consumption by Different Expenditure Groups

We classified households into different representative expenditure groups to observe the differences in the burden of cigarette taxation by expenditure level, which indicates the socioeconomic status of households. Each group was considered as a distinct sub-sample of the population, which allowed us to distinguish between the welfare loss of smokers to price increases. Quintiles are defined by the distribution of households in terms of expenditure per equivalent adult.

3.2. Models

3.2.1. The Model of Demand

Deaton and Muellbauer (8), for the first time, introduced the almost ideal demand system (AIDS). To describe the Iranians' household demand pattern, we estimated cigarette price elasticities using AIDS. The cost (expenditure) in this model is a function in the natural logarithmic form specified as follows:

$$lnc\ (u,\ p) = (1 -\ u)\ lna\ (p) +\ u\ lnb\,(p) \tag{1}$$

U lies between 0 (subsistence) and 1 (bliss); a(p) and b(p) could be considered as the costs of subsistence and bliss, respectively.

For each commodity i, the expenditure share is shown as follows:

$$w_i = a_i + \sum\nolimits_{(k=1)}^{n} r_{ik}\ lnp_k + \beta_i\ ln\left(\frac{M}{P}\right) \tag{2}$$

Where, wi is the share of commodity i in a household budget, defined as:

$$w_i\ = \frac{p_i q_i}{m}\ and \sum\nolimits_{i=1}^{n} w_i = 1 \tag{3}$$

Pk is the market price for commodity K, M represents consumer total expenditures or income, and P is an overall price index expressed as Equation 4, which could be approximated by Stone's price index in empirical applications.

$$lnp = a_0 +\ \sum\nolimits_{i=1}^{n} a_i lnp_i + \frac{1}{2}\sum\nolimits_{i=1}^{n}\sum\nolimits_{k=1}^{n} r_{ik} lnp_i lnP_k \tag{4}$$

In this function, the adding-up restriction implies:

$$\sum\nolimits_i a_i\ = 1,\ \sum\nolimits_i \beta_i = 0,\ \sum\nolimits_i r_{ik} = 0 \tag{5}$$

The following additional conditions must be satisfied if the equation system (4) is consistent with utility theory:

1) Homogeneity:

$$\sum\nolimits_k r_{ik} = 0 \tag{6}$$

i = 1, …, n

2) Symmetry:

$$r_{ik} = r_{ki} \tag{7}$$

i, k = 1, …, n

The linear AIDS model was estimated for 6 commodity groups, including cigarette, non-cigarette tobacco products, food, and soft drinks, housing, clothing, and other goods and services expenditure using the iterative seemingly unrelated regression (SUR) method.

Owing to multicollinearity, one equation is excluded and its estimates are examined using theoretical restrictions. Deaton and Muellbauer (8) recommend the use of Stone's index to avoid nonlinearities arisen from Equation 2. The index is defined as follows:

$$Log\ P = \sum\nolimits_{i=1}^{n} W_i log p_i \tag{8}$$

The model is known as a linear approximation of an almost ideal demand system when Stone's index is used in Equation 2. Using the price and expenditure share of each commodity group, Stone's price indices were constructed. Stone's price index in this paper allowed us to estimate the linear approximate AIDS model (i.e., LA-AIDS model).

3.3. Estimation

Informing decisions need an understanding of the variations in households' cigarette expenditure patterns across expenditure (income) groups. For this reason, we estimated the demand system separately for each quintile. The non-linear SUR was applied to estimate the LA-AIDS model. Parameter estimates of the demand system are not represented because they do not put an accurate interpretation of the parameter estimation, but they convey evidence on the model fit. The small P-values for most of the coefficients indicate a good fit of the demand system; many of the own-price elasticities of the commodities were negative. The following equations were used to estimate the parameters of the AL-AIDS model for each commodity by quintile separately:

$$W_1 = \alpha_1 + \gamma_{11}\, log\,(P_1) + \gamma_{12}\, log\,(P_2) + \\ + \gamma_{16}\, log\,(P_6) + \beta_1\, log\left(\frac{M}{P*}\right) + \epsilon \tag{9}$$

$$W_2 = \alpha_2 + \gamma_{21}\, log\,(P_1) + \gamma_{22}\, log\,(P_2) + \\ + \gamma_{26}\, log\,(P_6) + \beta_2\, log\left(\frac{M}{P*}\right) + \epsilon \tag{10}$$

$$W_3 = \alpha_3 + \gamma_{31}\, log\,(P_1) + \gamma_{32}\, log\,(P_2) + \\ + \gamma_{36}\, log\,(P_6) + \beta_3\, log\left(\frac{M}{P*}\right) + \epsilon \tag{11}$$

$$W_4 = \alpha_4 + \gamma_{41}\, log\,(P_1) + \gamma_{42}\, log\,(P_2) + \\ + \gamma_{46}\, log\,(P_6) + \beta_4\, log\left(\frac{M}{P*}\right) + \epsilon \tag{12}$$

$$W_5 = \alpha_5 + \gamma_{51}\, log\,(P_1) + \gamma_{52}\, log\,(P_2) + \\ + \gamma_{56}\, log\,(P_6) + \beta_5\, log\left(\frac{M}{P*}\right) + \epsilon \tag{13}$$

$$W_6 = \alpha_6 + \gamma_{61}\, log\,(P_1) + \gamma_{62}\, log\,(P_2) + \\ + \gamma_{66}\, log\,(P_6) + \beta_6\, log\left(\frac{M}{P*}\right) + \epsilon \tag{14}$$

Where, wi denotes the share of the ith commodity in the household budget, pk represents the price of the kth commodity, M is a total expenditure, and P^* is the Stone's price index. Parameters of the model above, including α_i, γ_{ii}, γ_{ik}, and β_i were estimated using SUR. Price elasticities of cigarettes for each quintile in the model were calculated using the formulas in the Appendix 1 in Supplementary File.

3.4. Welfare Analysis

The aim of this research was to understand the welfare effects of tax-induced increases in cigarette prices by estimating LA-AIDS parameters. Our measure to assess the welfare impact of a price change is the CV, suggesting the sum of money needed to be given to compensate a household for a change in prices and keep the original level of welfare. The CV can be defined using the expenditure function as follows:

$$CV = e\,(P_1,\ u_0) - e\,(P_0,\ u_0) \tag{15}$$

Where, e denotes the cost function, p represents the price vector, p_0 and p_1 are respectively the levels of prices before and after pricing policy, and u denotes the utility. Based on Shephard's lemma and second-order Taylor-series expansion on Equation 15, the effect of price changes on households welfare in the long-run is approximated as follows (9):

$$\frac{CV}{x_0} \cong CR_i \frac{\Delta p_i}{p_{0i}} + \frac{1}{2}\epsilon_d CR_i \left(\frac{\Delta p_i}{p_{0i}}\right)^2 \tag{16}$$

Where, $CR_i = \frac{p_{0i}\ q_i\ (p_0, x_0)}{x_0}$ is the share of a commodity in a household budget, p_i represents the price, q_i is the quantity of a demanded product, ε_d is own-price elasticity, and x_0 is the original income. Assuming that elasticities

are equal to zero, the short-run effect of a change in price on household welfare could be approximated as follow:

$$\frac{\Delta w^1}{x_0} \cong -\frac{\Delta p_i^c}{p_{0i}^c} CR_i \quad (17)$$

Where, Δw^1 represents the first-order approximation of the welfare loss from a change in price.

Based on the CV notion, Equations 16 are applied to quantify the effect of increased cigarette prices on family welfare.

4. Results

It would be of concern to identify the differential patterns of consumption across income groups to distill policy recommendations. In order to survey the pattern of cigarette demand in Iran, Table 1 represents statistics for cigarette expenditure and its budget share by quintile. The percentage of households with at least one smoker and the number of cigarettes smoked were highest in the middle quintiles (Table 1). Poorer households spend a larger share of their disposable income on cigarettes than wealthier counterparts.

4.1. Results of the Restrictions Test

Symmetry and homogeneity restrictions in the LA-AIDS household demand model for households were tested using the Wald test. The homogeneity restriction is used to explain the money illusion in an agent consumption decision. The null hypothesis and alternative hypothesis indicate homogeneous prices and non-homogeneous prices, respectively. The results showed that in most cases, the homogeneity condition for goods and services is rejected. In other words, households suffer from money illusion, that is, they make decisions depending on nominal rather than real monetary values. In addition, the symmetry restriction is imposed to equalize cross-price parameters estimated in the demand functions. As evident in Appendix 3 in Supplementary File, the P-value for testing symmetry restrictions was less than 5% with exception of the cross-price parameters between goods and services, including food and other expenditure. It deserves noting that the rejection of these two hypotheses is more common in the respective literature (Figure 1) (10).

1) Homogeneity	$\begin{cases} H_0: \sum_k^6 r_{ik} = 0 \\ H_A: \sum_k^6 r_{ik} \neq 0 \end{cases}$
2) Symmetry	$\begin{cases} H_0: r_{ik} = r_{ik} \\ H_A: r_{ik} \neq r_{ik} \end{cases}$

Figure 1. The null and alternative hypotheses

4.2. Demand Elasticities

We estimated elasticities for a cigarette for each expenditure quintile. Table 2 presents compensated (Hicksian), and uncompensated (Marshallian), own-price elasticities, and expenditure elasticity computed using the formula in Appendix 2 in Supplementary File. The own-price elasticities were all negative, which are in agreement with the theory concerning the price elasticities of demand. According to our findings, price elasticities of cigarette demand was different across the households, and the poorest quintile was the least price-elastic. Table 2 presents that Marshallian and Hicksian elasticities generally increase with total expenditure (that is; richer households are more sensitive to price changes).

The expenditure elasticities (Table 2) show that cigarettes are a normal good for richer quintiles, with elasticities between 0 and 1. In the same line, expenditure elasticity was greater than one for the poorer households, implying the strong sensitivity of cigarette demanded to changes in the income distribution in favor of the poorer households. In other words, the cigarette is considered a luxury good for the poorer smokers. As can be seen in Table 2, cigarette demand was relatively priced elastic among the top two expenditure quintiles and inelastic among the bottom three expenditure quintiles.

We simulated the welfare loss from increasing cigarette retail prices by 25%, 50%, and 75% (Taxes currently only contribute to about 21.7% of retail prices of cigarettes in Iran. We simulate a one-time excise tax fully passed onto consumers that results in the retail price of a pack of cigarettes increasing by 25%, which is closer to the current cigarette taxes. In the second scenario, the magnitude of the price increase of 50% is chosen because it would be a politically feasible change in tax. Finally, the reason why 75% increase in retail prices was simulated was that this increase is the WHO-recommended excise tax rate and is considered as the desired situation to be met by countries) in both the short and long run. The CV was computed by expenditure status (expenditure quintiles) to reveal which groups of smokers greatly suffered the loss from the increased price. Hicksian (compensated) elasticities were used to calculate the CV as an established approach in the literature (11). Tables 3 and 4 present long-run and short-run welfare loss from increased cigarette prices. On the assumption that consumers cannot re-

Table 1. Descriptive Statistics of Sample Households and Cigarette Use[a]

	Household Socioeconomic Status				
	Quintile 1 (Poorest)	Quintile 2	Quintile 3	Quintile 4	Quintile 5 (Wealthiest)
Sample size (households)	115,560	115,552	115,549	115,548	115,556
Average expenditure per equivalent adult, IR rials	1,754,994	3,003,238	4,061,518	5,412,067	9,440,985
Percentage of households with at least one smoker	16	20	21	21	19
Percentage of household expenditures spent on cigarettes	6	5	4	3	2
Number of cigarettes smoked per day	16	16.4	16.6	16.5	15.7
Price of a pack of cigarettes smoked, IR rials	25,148	26,649	35,657	39,411	34,156

[a] Source: Authors' calculations from the National Household Income and Expenditure survey (HIES) for the years 2001 - 2017.

Table 2. Elasticities by Expenditure Quintile Groups[a]

Elasticities	Poorest	2nd	3rd	4th	Richest
Marshallian	-0.93	-0.71	-0.90	-1.10	-1.11
Hicksian	-0.86	-0.66	-0.87	-1.07	-1.09
Expenditure	1.07	1.03	1.05	0.95	0.85

[a] Source: Authors' computation from model estimation.

spond to price changes in the short run, price elasticities are considered to be zero. The average exchange rate in 2017, according to the central bank of Iran database, was used to convert IR Rial to US dollar (1USD = 37,534 Rial).

The results indicated that smokers in all quintiles experienced welfare loss from increased cigarette prices. Findings also suggest that the welfare impact of cigarette price rise follows a regular but not linear pattern by expenditure groups. The poorest smokers, on average, require to be reimbursed by approximately 1.41% of their expenditure for the sake of a 25% increased price of cigarettes, but the welfare loss incurred by the richest group due to the same scenario is only 0.35% of their budget in the long-run. A comparison of corresponding values suggested that welfare effects are greater in the short-run, since smokers in a very short period of time do not change the quantity of cigarette demanded in response to the price increase.

To estimate the welfare impact of a simulated tax-induced cigarette price increase on smokers at the country level, the Iranian populations aged 15 and older were classified into 5 income groups using data on socioeconomic status released by SCI in 2018, and then the number of smokers in each quintile was calculated by multiplying the number of individuals in each group by the smoking prevalence rate of the same group. For each expenditure group, the number of smokers was the product of (i) the actual number of individuals in that expenditure group, and (ii) the prevalence of cigarette consumption. It is assumed that the cigarette prevalence among households is equivalent to that among men aged 15 years and over. This assumption mirrors the findings of several relevant studies (12, 13). Accordingly, the estimation of welfare loss from a 75% price increase in cigarettes -as is common in countries with strong tobacco control policies- in the long run and at the population level was examined (Appendix 1 in Supplementary File).

Although the magnitude of the cigarette tax burden from a 75% price increase that would fall on the richest quintile is four times as large as the poorest one, low-income smokers allocate a larger proportion of their budgets on cigarette and, as a result, experience increasing pressure on their budget.

5. Discussion

In this study, the notion of CV was employed to estimate the cost of a cigarette tax to smokers. Our estimates showed that in absolute terms, the amount of compensation to erase direct welfare loss from increasing the price of cigarettes is much greater for high-income smokers. However, the highest loss is suffered by households of the poorest quintile, who should afford 1.41%, 2.47%, and 3.20% more budget, in the long run, to stay at the same well-being as before, since poor smokers generally spend a larger share of their budget on tobacco than wealthier ones. Although taxation of tobacco products is at the core of the framework convention on tobacco control (FCTC), which was ratified by the Iranian Parliament in 2005, some policymakers

Table 3. Long-Run Welfare Losses Under 3 Cigarette Price Rise Scenarios (USD Per Year, Value 2001 - 2017)[a]

Quintiles	Increase 25%		Increase 50%		Increase 75%	
	CV, USD	CV, %	CV, USD	CV, %	CV, USD	CV, %
Poorest	10.83	1.41	19.06	2.47	24.67	3.20
2nd	21.32	1.01	38.80	1.84	52.45	2.48
3rd	24.68	0.74	43.34	1.29	55.98	1.67
4th	26.48	0.54	44.79	0.92	54.92	1.12
Richest	34.24	0.35	57.68	0.58	70.32	0.71

[a] Source: Authors' calculation.

Table 4. Short-Run Welfare Losses Under 3 Cigarette Price Rise Scenarios (USD Per Year, Value 2001 - 2017)[a]

Quintiles	Increase 25%		Increase 50%		Increase 75%	
	CV, USD	CV, %	CV, USD	CV, %	CV, USD	CV, %
Poorest	12	1.6	24	3.1	36	4.7
2nd	23	1.1	46	2.2	70	3.3
3rd	28	0.8	55	1.6	83	2.4
4th	31	0.6	61	1.2	92	1.8
Richest	40	0.4	79	0.8	119	1.2

[a] Source: Authors' calculation.

have invoked the regressivity of tobacco excise taxes as an argument to oppose tax increases. This argument is based on the fact that increased taxes accrue disproportionately to the poor households, who spend a higher percentage of their disposable income on smoking than the well-off households (14).

According to the findings, the expenditure elasticity of cigarettes is positive and greater than one for poorer quintiles, indicating cigarette smoking is a luxury good for them, which mean that when a smoker's income (expenditures) increases, the cigarette budget share in total expenditures escalates. The results of the current study confirm those of Sahabi et al. (15), who found that the price elasticity of tobacco group for richer households (income deciles nine and ten) is greater than one. This finding also is in agreement with estimated elasticities for Lebanon (-1.54) (16). Many studies on cigarette elasticity using the AIDS model found that elasticity ranges from -0.33 (in Spain) (17) to -1.188 (in the U.S.) (18). A range of evidence-based policy and program interventions to design requires identifying those who have been most harmed and the quantity of that harm. The results of cigarette price elasticities indicate that richer smokers are more sensitive to price changes than the poorer equivalents. Therefore, the government should take twofold measures; increase cigarette prices by international levels to attain the targets that are in line with tobacco control programs and targeted support of households, who are more vulnerable. The findings indicate that the demand for cigarettes in Iran is relatively price- sensitive. Thus, concerning direct welfare loss from the cigarette taxation reform in Iran, and focusing on low-income groups, such a policy can be considered as regressive. In response to the regressive nature of sin taxes, leading experts recommend that a corrective tax might provide greater benefits to the disadvantaged than the well-off. Smoking, for instance, is causally associated with developing lung cancer, stroke, heart diseases, and other adverse health impacts that disproportionately affect low-income families (5). In this regard, a study conducted in China demonstrated that people of the lowest socioeconomic status gained a higher proportion of health benefits compared with the additional tax burden they would bear (19). The main point of our analysis is that smokers in the two bottom quintiles representing 40% of the Iranian population bear only 29% of the tax burden arising from the cigarette price increase, whereas that is 27% for the richest quintile. This evidence is sufficient to conclude that a large proportion of excise tax revenue as a result of raising cigarette prices would be paid by richer smokers. Therefore, redistributive pro-poor policies might mitigate the welfare loss to the poorer smokers, and reduce social and economic inequalities. Moreover, it should be noted that consumers do vary in the value of marginal utility from an extra dollar saved (5). The findings offer valuable evidence

to inform decisions about tobacco taxation as an instrument for upholding tobacco-control programs and compensating welfare loss for the most affected households.

Our study has several strengths. This study demonstrated, for the first time, the cost of taxing cigarettes in Iran using the CV approach. The key strength of this study is its nation-wide representative data set, indicating that our analyses were performed to estimate the cigarette demand system. Moreover, rich data on some household financial indicators, such as income and expenditure for different groups of commodities were available. There are several limitations. First, due to the lack of data, this paper cannot provide a comprehensive review of consequences in both the health and non-health domains. To access the total health and financial impacts of cigarette taxation from the societal vantage point, a variety of costs accrued by the formal sector (for example, healthcare and the environment) should be regarded. Second, cigarette prices in Iran vary depending on its brand, allowing smokers to switch to lower-priced brands in reaction to taxes increase. Due to the lack of data, we could not examine how changes in relative prices may lead to a substitution effect in consumer behavior. However, further research needs to be done to quantify the magnitude of the switching effect and identify smokers who are more likely to switch to determine an optimum level of taxation. Third, we assumed that excise tax would be fully passed onto the consumers, if it was not fully (but partially) passed onto them, the welfare loss from taxing tobacco would be undermined.

Supplementary Material

Supplementary material(s) is available here [To read supplementary materials, please refer to the journal website and open PDF/HTML].

Footnotes

Authors' Contribution: SE, AT, and BR initiated and conceptualized the study. BR coordinated the research under the supervision of SE did the analysis. GA, SE, and BR wrote the first draft of the report. SE and GA reviewed the report and provided advice and editing suggestions. SE and AT approved the final version.

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