



## Estimates of price and income elasticity in Greece: Greek debt crisis transforming cigarettes into a luxury good

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## **Abstract**

**Objective:** During the past decades, smoking prevalence in Greece was estimated near or over 40%. Following a sharp fall in newest data on cigarette consumption, our objective is to assess smokers' sensitivity to cigarette price and consumer income changes as well as to project health benefits of an additional tax increase.

**Methods:** Cigarette consumption was considered as the dependent variable, with Weighted Average Price as a proxy for cigarette price, GDP as a proxy for consumers' income and dummy variables reflecting smoking restrictions and antismoking campaigns. Values were computed to natural logarithms and regression was performed. Then, 4 scenarios of tax increase were distinguished in order to calculate potential health benefits.

**Results:** Addiction models were unable to provide statistically significant information due to a nearly 23.5% drop in consumption during 2012. Short-run price elasticity is estimated at -0.441 and short-run income elasticity is estimated at 1.040. Antismoking campaigns were found to have a statistically significant impact on consumption. Results indicate that, depending on the level of tax increase, annual per capita consumption could fall by at least 209.83 cigarettes; tax revenue could rise up by more than €0.74 billion, while smokers could be reduced by up to 530,568 and at least 465 smoking related deaths could be averted.

**Conclusions:** Price elasticity estimates are similar to previous studies in Greece, while income elasticity estimates are far greater. With cigarettes regarded as a luxury good, a great opportunity is presented for decision-makers to counter smoking. Increased taxation, along with focused antismoking campaigns, law reinforcement (to ensure compliance with smoking bans) and intensive control for smuggling could invoke a massive blow to the tobacco epidemic in Greece.

### Article Summary

- The article offers information to policy makers regarding price elasticity, a key measure to perform tobacco control policy
- The article reports, for the first time, an income elasticity above 1, as evidence that cigarettes tend to be considered a luxury good in Greece
- The analysis treats qualitative variables and projects health and financial benefits under extreme austerity
- The analysis could not include dynamic (addiction) models, as no statistical significance was reported

## Introduction

### Country Profile

Globally, more than 5 million people die every year from tobacco use, while tobacco use is the second leading cause of death, representing the 8.7% of global annual mortality .[1] As global tobacco consumption in 2009 was estimated at 5884 billion cigarettes,[2] tobacco clearly reflects the global transition from traditional risks such as undernutrition, unsafe sex, unsafe water, poor sanitation and hygiene to modern risks like physical inactivity, behavior risks and air quality.[1] In Greece, WHO estimations attribute 17% of mortality for people aged 30 or more to smoking.[3] Death rate attributed to tobacco and the proportion of deaths attributable to tobacco for ages 30 and over is documented in the following table (Table 1).

Table 1: Estimated death rated (per 100.000) and proportion attributable to tobacco for ages 30 and over, 2004 in Greece[3]

Cause of death	Death rate attributed to tobacco	Proportion of deaths attributable to tobacco
Lower respiratory infections	3	23%
Malignant neoplasms	110	29%
Cardiovascular diseases	90	12%
Respiratory diseases	23	37%

Little less than half Greek citizens (41%) are smokers.[4] Youth smoking is also high, 11.3% for young men and 9% for young women.[2] Environmental Tobacco Smoke (ETS) also represents a serious problem in Greece, as documented by previous research.[5]

Concerning cigarette affordability, findings suggest that Greece is one of the few high-income European Union countries with relatively low cigarette prices.[6] Low prices can be recognized as a factor for the tobacco epidemic in Greece.[7] According to own calculations,

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3 for the period 1992-2012, cigarette affordability, defined as the percentage of income  
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5 needed to purchase 100 packs of cigarettes, was estimated from 0.56% to 1.98%.  
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8 The first organized efforts to counter smoking in Greece were observed during 1979-1982.  
9  
10 At the moment, in Greece, tobacco advertising bans are complete, except for point-of-sale  
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12 advertising.  
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15 Tax revenue from tobacco products is arguably very important for the economic policy. In  
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17 1990, tax revenue accounted for 4.4% of GDP.[8] For the period 1998-2010 tobacco tax  
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19 revenue stood for an annual average 2% of GDP, but it seems to follow a downwards trend.  
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23 Official estimates measure the total annual direct cost of smoking a €2.14 billion, in an  
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25 environment where debt crisis and austerity measures set serious constraints to the health  
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27 system and resources should, now more than ever, be allocated properly. [9] Tobacco's  
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29 unfavorable consequences on the poor could become a factor, where unemployment rates  
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31 are estimated at 27.1% for the 2<sup>nd</sup> quarter of 2013, continuing to grow from under 900,000  
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33 to approximately 1,350,000 people in the last 24 months.[10] Moreover, 31% of the total  
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35 population is at risk of poverty or social exclusion.[11]  
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### 38 Tobacco Market and government interventions

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41 Three market failures differentiate an individual's choice to smoke compared to the decision  
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43 to consume other goods: information failure on the health hazard of smoking, information  
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45 failure on the addiction caused by smoking and external burden to non-smokers.[12]  
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48 Therefore, government intervention is justified in order both to protect smokers from the  
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50 perilous habit and correct for externalities associated to smoking. From a basic economics'  
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52 standpoint, it can be claimed that smoking's immense social cost overtakes the excess  
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54 burden of taxation or else the loss of economic efficiency. The deadweight loss after the  
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56 introduction of tax is illustrated figures (Figure 1 and Figure 2).  
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3 Tobacco taxation is imposed through a variety of structures but, in nearly all cases, includes  
4 two main types of tax: Ad valorem tax, which represents a percentage of price and specific  
5 tax, which is a fixed tax per cigarette. In Greece, following the 2010 restructure of tobacco  
6 tax, total tax represents 86% of the retail price, significantly increased compared to the 2009  
7 level and 2008 level when is represented 83% and 70% of the retail price respectively (WHO,  
8 2011). In 2012, specific excise tax was regulated at 80€ per 1,000 cigarettes and ad valorem  
9 tax at 20% of the retail price. Their minimum sum is required to be no less than 115€ per  
10 1,000 cigarettes. Meanwhile, a specific excise tax was set at 153€ per kg of hand-rolled  
11 tobacco. Sales tax for cigarettes is fixed at 23% of the retail price.

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14 Price increases should not be regarded the only way to reduce consumption, as the impact  
15 of income, advertising and health education are also important.[13] Manipulating these  
16 variables will result to reduced consumption and eventually reduced mortality and  
17 morbidity. Tobacco control programs and policies are found to be either cost-saving or cost-  
18 effective, compared to other public health interventions such as cardiovascular risk  
19 counseling and cancer screening.[14] Research on the impact of tobacco control showed  
20 that during 1981-2000, increases in tobacco control program expenditures in the U.S.A. lead  
21 to reduced cigarettes sales. Authors also suggest that expenditures have an even stronger  
22 lagged influence on sales.[15] Smoking bans are adopted in order to limit exposure to smoke  
23 but also cause a remarkable decrease in cigarette consumption, as smokers' opportunities to  
24 smoke are lessened.[16] In Greece, the effort to restrict smoking in public places through  
25 legislation has failed due to low compliance with law.[17] Youth exposed to secondhand  
26 smoke at home are estimated at 89.8% of total youth population.[2] Public education  
27 campaigns, if "hard-hitting, sophisticated and sustained", can be extremely effective.[18]

### Price and income elasticities

The term used to measure the impact of a change in price on consumption is price elasticity of demand, defined as the percentage change in consumption that results from 1 percent increase in price.[19] Similarly, the impact of a change in income on consumption is measured by income elasticity, defined as the percentage change in consumption resulting from 1 percent increase in income. Estimating elasticity is crucial to policy makers in order not only to anticipate an intervention's impact both on tobacco consumption and tobacco tax revenue. If the proportionate fall in tobacco consumption exceeds the proportionate increase of tax, revenue will fall. Otherwise, revenue will rise.[16]

Results from a meta-analysis,[20] indicate that short run elasticity (-0.40) is lower than long run elasticity (-0.44), while in studies that included smuggling demand was less sensitive (-0.36). These findings confirm the general notion that a 10% increase in price would lead to a 4% reduction in consumption in high-income countries.[18] Stavrinou estimated the short run price elasticity at -0.079 and the long run at -0.147, while income elasticity is estimated at 0.18 and 0.33, respectively.[21] Hondroyannis and Papapetrou, based on data over the period 1967-1990, calculated the short run price elasticity at -0.33 and the long run at -0.6, while income elasticity estimations are 0.35 and 0.54, respectively. The fact that demand is inelastic is explained by the authors through addiction and the absence of direct substitutes. Furthermore, it is claimed that health warnings are more effective in reducing consumption than price increases.[9] Raptou and colleagues conclude in an income elasticity of 0.28, consisting of initiation elasticity (0.21) and consumption elasticity (0.07), arguing that income is a more important determinant for initiation rather than consumption. Furthermore, smoking bans are illustrated as a factor discouraging tobacco consumption.[22] Nikolaou and Velentzas, based on data from 1960 to 1995, estimated the short run price elasticity at -0.24 and the long run at -0.48, while income elasticity is



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3 estimated at 0.19 and 0.40, respectively. Advertising had a positive but insignificant effect  
4 on demand and antismoking campaigns had a negative but insignificant effect on  
5 demand.[23] On the other hand, health warnings on packs during 1987-1990 had a  
6 significant negative impact on demand, lowering consumption by 4.2%. Dritsakis notes that  
7 consumption is a negative function of price and health education expenditure and a positive  
8 function of income as well.[24]  
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12 As illustrated, there are no studies of price elasticity available for at least a decade. In the  
13 light of the above, the purpose of the present study was to investigate cigarette demand in  
14 Greece.  
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### 16 17 18 **Method**

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21 The tobacco product used in analysis is cigarettes, widely accepted as the major tobacco  
22 product. In order to account for population growth, annual consumption per person over 15  
23 was preferred to aggregate annual consumption. The threshold age was set at 15, as youth  
24 smoking in Greece is considered substantial. Data on cigarette consumption are available  
25 from 1994 onwards.  
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29 Monthly (and quarterly) data on the quantities of taxed cigarettes were available from 2007  
30 to 2011. As excise tax data were not available and MPPC (Most Popular Price Category)  
31 shows inconsistency due to pricing policy, the measure chosen to reflect price was the  
32 Weighted Average Price. Each pack consists of 20 cigarettes. The proxy used to deflate  
33 nominal into real prices was calculated by comparing real and nominal values of GDP (Gross  
34 Domestic Product) derived from World Bank. CPI (Consumer Price Index) was not selected as  
35 a proxy due to a change in calculations by Hellenic Statistical Authority in 1995, when  
36 General Harmonized Consumer Price Index was introduced. The base year set was 2005.  
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38 Disposable income data were based at GDP. Again, the threshold age was set at 15.  
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3 Deflation was not needed in that case, as real values were available. The base year set was  
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5 2005. Prior to 2008, national informative campaigns were not run in Greece at a national  
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7 level. We considered The National Action Plan for Cancer (2008) as an anti-smoking  
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9 campaign. A dummy variable was used to measure its influence on consumption.  
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11 Expenditure on tobacco control was not available. Regulation for smoking bans and  
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13 restrictions was only introduced in 2002 and amended in 2010. In order to measure its  
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15 influence on consumption, an adjusted version of a previous reliable index was constructed,  
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17 accounting not only for intensity of smoking restrictions but for compliance as well.[25]  
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19 Values attributed were between 0 (no restrictions) to 1 (total ban) escalating by 0.25.  
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23 Regression analysis includes only a static model, as dynamic models (incorporating models)  
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25 show limited statistical significance, due to the inclusion of 2012 data in the time series.  
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29 The functional form used in the analysis was Double-log. Testing for endogeneity of cigarette  
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31 prices was not possible as the annual tax rates were only available from 2008 onwards. Time  
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33 trend was found to be insignificant; therefore, it is excluded from the equations. The model  
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35 of demand was specified as follows.  
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38 *Conventional Demand Model*

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$$\ln Q_t = b_0 + b_1 \ln P_t + b_2 \ln Y_t + b_3 SR_t + b_4 AsC_t + \epsilon_t$$

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44 Where,

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47  $Q_t$ : consumption of cigarettes per person over 15 (000 cigarettes) in year t

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50  $P_t$ : real retail price per pack of 20 cigarettes in year t

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53  $Y_t$ : real per person over 15 disposable income (000 €) in year t

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56  $b_0$ : intercept in year t  
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3  $SR_t$  : index of smoking restrictions in year t  
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6  $AsC_t$ : dummy checking the existence of an anti-smoking campaign each year t  
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9  $\varepsilon_t$  : the error term  
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## Results

Through the conventional model of demand, the demand equation was estimated as follows:

$$\ln Q_t = -1.757 - 0.441 \ln P_t + 1.040 \ln Y_t - 0.132 \text{AsC}_t$$

F-statistic: 27.765

R square: 0.847

Durbin-Watson: 1.980

Calculations were made stepwise. The variable created to capture the effect of smoking restrictions was found insignificant; thus, it is excluded from the model. P value at 5% confidence level is asymptotically equal to 0 for  $\ln Y_t$ , equal to 0.001 for  $\ln P_t$  and equal to 0.021 for  $\text{AsC}_t$ . The F-statistic is high, showing a good level of fit, while the model explains a great part of the variation. The Durbin-Watson statistic is close to 2, suggesting that the model has no autocorrelation. The Variation Inflated Factor is low for all variables, implying that multicorellation is a non-factor. Therefore, we accept a short-run price elasticity of demand at 0.441 and a short-run income elasticity of demand at 1.040.

Based on 2010 data, tax revenue per pack is calculated at 2.78€, a value verifying and corresponding to the fixed amount of tax (86% of the nominal retail price). We assume that the state maintains the existing ability to collect tribute. Government proclamations suggest that tobacco will be further taxed. Therefore, we distinct four scenarios, all with retail price increases as anticipated, each suggesting an additional price increase by 0.5€. Calculations are made only for the following year and accordingly only short run elasticity is taken into account. Scenarios capture the impact of the continuing fall in income at a rate of 4.8%.

Based on Ross et al methodology and data concerning tobacco-related mortality in Greece

(Lower respiratory infections, Malignant neoplasms, Cardiovascular diseases and Respiratory diseases), we estimate reduction on smokers and mortality averted.[3,26]

Table 2: Impact of price increase and income constraints on consumption, tax revenue, number of smokers and smoking related deaths

Model scenarios	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Price per pack	4.47 €	4.97 €	5.47 €	5.97 €
Percent increase of price	12.59%	25.19%	37.78%	50.38%
Fall in consumption due to price increase	-5.55%	-11.11%	-16.66%	-22.22%
Fall in consumption due to income decrease	-4.99%	-4.99%	-4.99%	-4.99%
Per capita consumption level	1,779.84	1,669.33	1,558.82	1,448.31
Per capita consumption deterred	209.83	320.34	430.85	541.36
Tax revenue per pack	3.84 €	4.27 €	4.70 €	5.13 €
Tax revenue per cigarette	0.192 €	0.214 €	0.235 €	0.257 €
Total tax revenue (€ billion)	3,336 €	3,478 €	3,575 €	3,625 €
Incremental tax revenue (€ billion)	0,455 €	0,597 €	0,694 €	0,744 €
Reduction in number of smokers	205,650	313,956	422,262	530,568
Smoking related deaths averted	high(0,50)	930	1,420	1,911
	low(0,25)	465	710	955

-Differences in calculations may occur due to rounding

-Impact of price increase shared between prevalence and consumption

-High estimate indicates that 50% of smokers' deaths are attributable to tobacco use, whereas low estimate indicates that 25% of smokers' deaths are attributable to tobacco use

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3 In all four scenarios, consumption is decreased substantially while tax revenue is still  
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5 increased thanks to the inelastic demand. Moreover, smokers are significantly reduced and  
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7 smoking related deaths are accordingly limited.  
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### 10 Discussion

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12 Price elasticity estimates are greater than previous research in Greece,[8, 23-24] but  
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14 consistent with findings by Gallet and List.[20] Estimates for income elasticity are far greater  
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16 than estimates provided by literature in Greece.[8, 21-23] Regarding antismoking campaigns,  
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18 results are in agreement with previous testimony.[23-24] Smoking restrictions show no  
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20 statistical significance, confirming the claims by Joosens and Raw that compliance is low.[17]  
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22 Finally, results are in general agreement with Alpert et al,[27] though a different  
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24 methodology is followed.  
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29 Paired with the still high cigarette affordability, as documented in the current study and  
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31 reported by previous research,[6] the nature of demand in Greece presents a vast  
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33 opportunity for the policy makers to counter the tobacco epidemic and ensure revenue and  
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35 cash flows at the same time. Even supposing that other determinants of demand, such as  
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37 income, which is anticipated to fall, do not change, tobacco taxation proves to be a powerful  
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39 tool. Annual consumption per person over 15 would be no higher than 1,780 cigarettes,  
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41 even in the worst case (scenario1) and may fall to less than 1,448 cigarettes. On the other  
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43 hand, tax revenue would recover from the downwards trend, accounting again for more  
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45 than 1.80% of GDP, even in scenario1. In absolute values, excess tobacco tax revenue could  
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47 rejuvenate the dismantled public coffers. Results suggest that even with a modest 10% of  
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49 tax revenue allocated to offsetting the tobacco epidemic, there would be more than enough  
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51 disposable funds towards planning, implementing, evaluating and improving antismoking  
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53 efforts. Greeks seem to be in agreement with heavy taxation on cigarettes, but only if  
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55 respective revenue is attributed to tobacco control.[28] In terms of public health benefits,  
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3 smokers could be reduced by nearly 530,568 people, while up to 2,401 smoking related  
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5 deaths could be averted on an annual basis. Nonetheless, findings should be treated with  
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7 caution and increases in price should not be excessively increased from day one, as the  
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9 smokers' reaction is not easy to predict with confidence intervals widened. A stepwise  
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11 increase of tax would eliminate many of the risks associated with a sharp and sudden  
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13 increase in cigarette prices. Besides, Greece already performs better in tax collection than  
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15 countries such as Germany, France and Slovenia among others,[26] as the excise per smoker  
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17 ratio indicates, with 738.71€ collected for every smoker.

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21 Income sensitivity is larger than in any previous study either in Greece or internationally.  
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23 Thus, it is not exaggerating to argue that Greek smokers are shocked by the constraint on  
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25 their income. Besides, it is the first time in at least 40 years that income in Greece is falling at  
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27 this rate. The austerity measures should be viewed as a shift event in cigarette consumption,  
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29 among others.

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33 Reducing the toll of tobacco in Greece is not an easy task. Decisions should include fostering  
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35 an antismoking-culture through well-planned national antismoking campaigns, raising the  
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37 cigarettes prices at an initial level no less than 4€ a pack and ensuring compliance with the  
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39 anti-smoking law, especially on the current occasion, when City Police (the main mechanism  
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41 of control on the matter) was recently abolished as an institution. Controlling illicit trade is  
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43 crucial to maximize the effect of interventions.

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47 Possible future analysis of an even wider time series could provide even more reliable  
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49 results, as multicollinearity could be fully cured. Moreover, the current study is based on the  
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51 most popular price category in order to estimate the impact of prices changes on cigarette  
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53 demand. It is possible that a weighted average for all the brands sold in Greece could  
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55 eliminate unilateralism on prices data. Still, the anticipated but not fully documented switch  
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57 of Greek smokers from manufactured cigarettes to hand-rolled tobacco should be taken into  
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3 account in any future research. Yet, if the increase of contraband cigarettes in the Greek  
4 market could be quantified, results would be more punctual. In addition, tobacco shows  
5 synergistic effect with other substances, such as alcohol. Thus, it would be meaningful to  
6 investigate the combined effect of tobacco and alcohol from an economic aspect. Finally,  
7 researchers argue that the increased availability of nicotine substitutes will reduce demand  
8 for tobacco products and increase the price sensitivity as well.[19] Under that scope, if  
9 research included nicotine substitutes, accuracy would be improved.

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19 **Contributorship Statement:** FT and AV performed the calculations and analyses reported in  
20 the text. FT and KA reviewed the literature for relevant data and documentation. FT and KA  
21 drafted the manuscript which was edited and critically revised by KA and JK.

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60 **Data Sharing:** Extra data is available by emailing FT.



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**Figures**

Figure 1: The demand curve before government intervention

Figure 2: The demand curve after government intervention

For peer review only

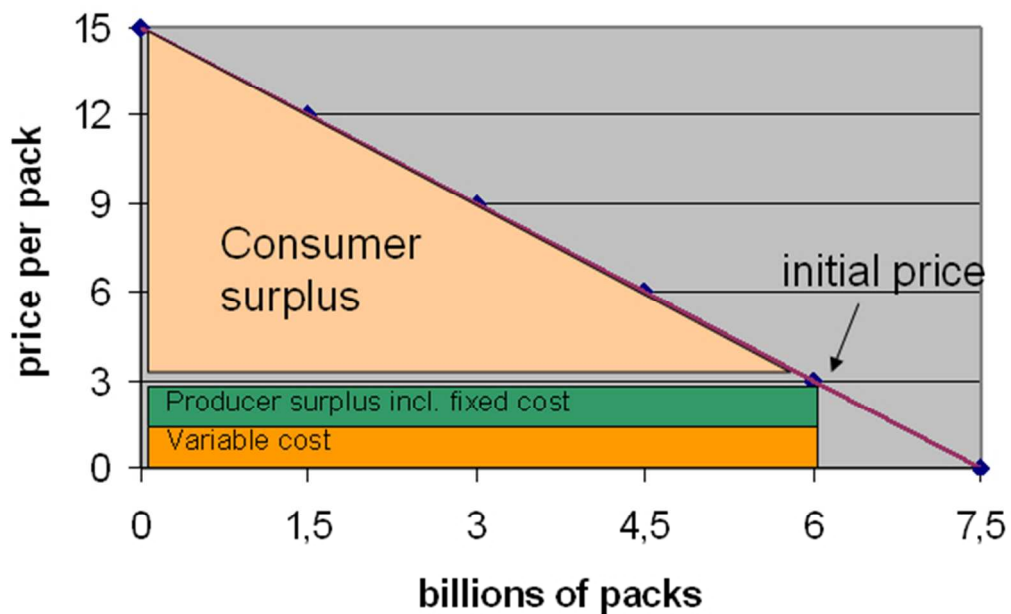


Figure 1: The demand curve before government intervention

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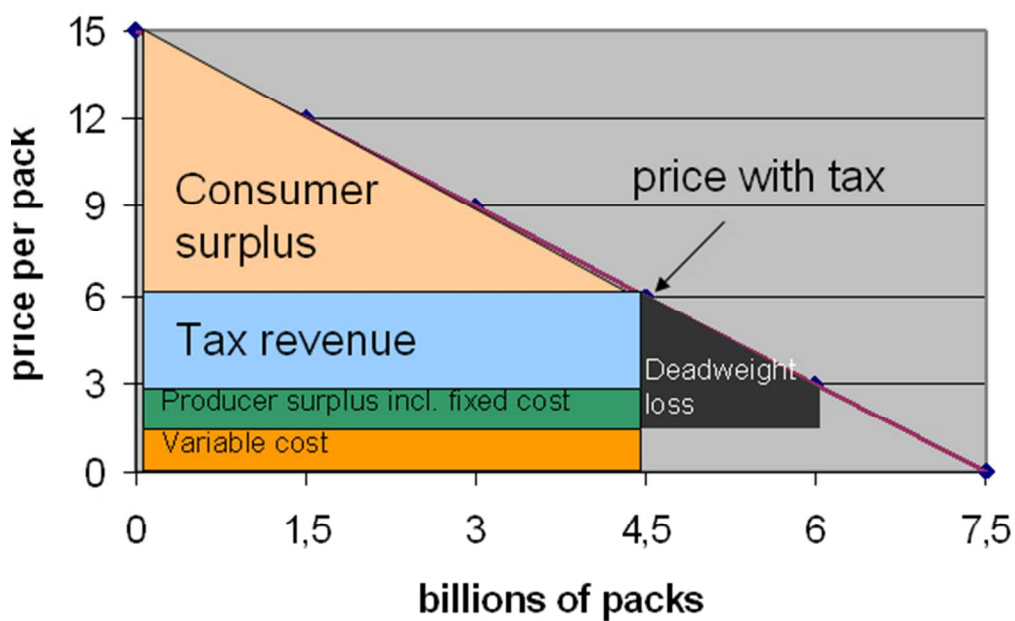


Figure 2: The demand curve after government intervention

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# BMJ Open

## Estimates of price and income elasticity in Greece: Greek debt crisis transforming cigarettes into a luxury good - an econometric approach

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**Estimates of price and income elasticity in Greece:**

**Greek debt crisis transforming cigarettes into a luxury good - an econometric approach**

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## **Abstract**

**Objective:** During the past decades, smoking prevalence in Greece was estimated near or over 40%. Following a sharp fall in newest data on cigarette consumption, our objective is to assess smokers' sensitivity to cigarette price and consumer income changes as well as to project health benefits of an additional tax increase.

**Methods:** Cigarette consumption was considered as the dependent variable, with Weighted Average Price as a proxy for cigarette price, GDP as a proxy for consumers' income and dummy variables reflecting smoking restrictions and antismoking campaigns. Values were computed to natural logarithms and regression was performed. Then, 4 scenarios of tax increase were distinguished in order to calculate potential health benefits.

**Results:** Short-run price elasticity is estimated at -0.441 and short-run income elasticity is estimated at 1.040. Antismoking campaigns were found to have a statistically significant impact on consumption. Results indicate that, depending on the level of tax increase, annual per capita consumption could fall by at least 209.83 cigarettes; tax revenue could rise up by more than €0.74 billion, while smokers could be reduced by up to 530,568 and at least 465 smoking related deaths could be averted.

**Conclusions:** Price elasticity estimates are similar to previous studies in Greece, while income elasticity estimates are far greater. With cigarettes regarded as a luxury good, a great opportunity is presented for decision-makers to counter smoking. Increased taxation, along with focused antismoking campaigns, law reinforcement (to ensure compliance with smoking bans) and intensive control for smuggling could invoke a massive blow to the tobacco epidemic in Greece.

### Strengths and limitations of this study

- The article offers information to policy makers regarding price elasticity, a key measure to perform tobacco control policy
- The article reports, for the first time, an income elasticity above 1, as evidence that cigarettes tend to be considered a luxury good in Greece
- The analysis treats qualitative variables and projects health and financial benefits under extreme austerity
- The analysis could not include dynamic (addiction) models, as no statistical significance was reported

## Introduction

### Country Profile

Globally, more than 5 million people die every year from tobacco use, while tobacco use is the second leading cause of death, representing the 8.7% of global annual mortality .[1] As global tobacco consumption in 2009 was estimated at 5884 billion cigarettes,[2] tobacco clearly reflects the global transition from traditional risks such as undernutrition, unsafe sex, unsafe water, poor sanitation and hygiene to modern risks like physical inactivity, behavior risks and air quality.[1] In Greece, WHO estimations attribute 17% of mortality for people aged 30 or more to smoking.[3] Death rate attributed to tobacco and the proportion of deaths attributable to tobacco for ages 30 and over is documented in the following table (Table 1).

Table 1: Estimated death rated (per 100.000) and proportion attributable to tobacco for ages 30 and over, 2004 in Greece [3]

Cause of death	Death rate attributed to tobacco	Proportion of deaths attributable to tobacco
Lower respiratory infections	3	23%
Malignant neoplasms	110	29%
Carciovascular diseases	90	12%
Respiratoty diseases	23	37%

Little less than half Greek citizens (41%) are smokers.[4] Youth smoking is also high, 11.3% for young men and 9% for young women.[2] Environmental Tobacco Smoke (ETS) also represents a serious problem in Greece, as documented by previous research.[5]

Concerning cigarette affordability, findings suggest that Greece is one of the few high-income European Union countries with relatively low cigarette prices.[6] Low prices can be

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3 recognized as a factor for the tobacco epidemic in Greece.[7] According to own calculations,  
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5 for the period 1992-2012, cigarette affordability, defined as the percentage of income  
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7 needed to purchase 100 packs of cigarettes, was estimated from 0.56% to 1.98%.

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10 The first organized efforts to counter smoking in Greece were observed during 1979-1982.  
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12 At the moment, in Greece, tobacco advertising bans are complete, except for point-of-sale  
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14 advertising.

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17 Tax revenue from tobacco products is arguably very important for the economic policy. In  
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19 1990, tax revenue accounted for 4.4% of GDP.[8] For the period 1998-2010 tobacco tax  
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21 revenue stood for an annual average 2% of GDP, but it seems to follow a downwards trend.  
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25 Official estimates measure the total annual direct cost of smoking a €2.14 billion, in an  
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27 environment where debt crisis and austerity measures set serious constraints to the health  
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29 system and resources should, now more than ever, be allocated properly. [9] Tobacco's  
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31 unfavorable consequences on the poor could become a factor, where unemployment rates  
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33 are estimated at 27.1% for the 2<sup>nd</sup> quarter of 2013, continuing to grow from under 900,000  
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35 to approximately 1,350,000 people in the last 24 months.[10] Moreover, 31% of the total  
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37 population is at risk of poverty or social exclusion.[11]  
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#### 40 41 Tobacco Market and government interventions

42  
43 Three market failures differentiate an individual's choice to smoke compared to the decision  
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45 to consume other goods: information failure on the health hazard of smoking, information  
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47 failure on the addiction caused by smoking and external burden to non-smokers.[12]  
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50 Therefore, government intervention is justified in order both to protect smokers from the  
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52 perilous habit and correct for externalities associated to smoking. From a basic economics'  
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54 standpoint, it can be claimed that smoking's immense social burden overtakes the loss of  
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56 consumer's utility or else the loss of economic efficiency (deadweight loss).  
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3 Tobacco taxation is imposed through a variety of structures but, in nearly all cases, includes  
4 two main types of tax: Ad valorem tax, which represents a percentage of price and specific  
5 tax, which is a fixed tax per cigarette. In Greece, following the 2010 restructure of tobacco  
6 tax, total tax represents 86% of the retail price, significantly increased compared to the 2009  
7 level and 2008 level when is represented 83% and 70% of the retail price respectively (WHO,  
8 2011). In 2012, specific excise tax was regulated at €80 per 1,000 cigarettes and ad valorem  
9 tax at 20% of the retail price. Their minimum sum is required to be no less than €115 per  
10 1,000 cigarettes. Meanwhile, a specific excise tax was set at €153 per kg of hand-rolled  
11 tobacco. Sales tax for cigarettes is fixed at 23% of the retail price.

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14 Price increases should not be regarded the only way to reduce consumption, as the impact  
15 of income, advertising and health education are also important.[13] Manipulating these  
16 variables will result to reduced consumption and eventually reduced mortality and  
17 morbidity. Tobacco control programs and policies are found to be either cost-saving or cost-  
18 effective, compared to other public health interventions such as cardiovascular risk  
19 counseling and cancer screening.[14] Research on the impact of tobacco control showed  
20 that during 1981-2000, increases in tobacco control program expenditures in the U.S.A. lead  
21 to reduced cigarettes sales. Authors also suggest that expenditures have an even stronger  
22 lagged influence on sales.[15] Smoking bans are adopted in order to limit exposure to smoke  
23 but also cause a remarkable decrease in cigarette consumption, as smokers' opportunities to  
24 smoke are lessened.[16] In Greece, the effort to restrict smoking in public places through  
25 legislation has failed due to low compliance with law.[17] Youth exposed to secondhand  
26 smoke at home are estimated at 89.8% of total youth population.[2] Public education  
27 campaigns, if "hard-hitting, sophisticated and sustained", can be extremely effective.[18]

### Price and income elasticity

The term used to measure the impact of a change in price on consumption is price elasticity of demand, defined as the percentage change in consumption that results from 1 percent increase in price.[19] Similarly, the impact of a change in income on consumption is measured by income elasticity, defined as the percentage change in consumption resulting from 1 percent increase in income. Estimating elasticity is crucial to policy makers in order not only to anticipate an intervention's impact both on tobacco consumption and tobacco tax revenue. If the proportionate fall in tobacco consumption exceeds the proportionate increase of tax, revenue will fall. Otherwise, revenue will rise.[16]

Results from a meta-analysis,[20] indicate that short run elasticity (-0.40) is lower than long run elasticity (-0.44), while in studies that included smuggling demand was less sensitive (-0.36). These findings confirm the general notion that a 10% increase in price would lead to a 4% reduction in consumption in high-income countries.[18] Stavrinou estimated the short run price elasticity at -0.079 and the long run at -0.147, while income elasticity is estimated at 0.18 and 0.33, respectively.[21] Hondroyannis and Papapetrou, based on data over the period 1967-1990, calculated the short run price elasticity at -0.33 and the long run at -0.6, while income elasticity estimations are 0.35 and 0.54, respectively. The fact that demand is inelastic is explained by the authors through addiction and the absence of direct substitutes. Furthermore, it is claimed that health warnings are more effective in reducing consumption than price increases.[9] Raptou and colleagues conclude in an income elasticity of 0.28, consisting of initiation elasticity (0.21) and consumption elasticity (0.07), arguing that income is a more important determinant for initiation rather than consumption. Furthermore, smoking bans are illustrated as a factor discouraging tobacco consumption.[22] Nikolaou and Velentzas, based on data from 1960 to 1995, estimated the short run price elasticity at -0.24 and the long run at -0.48, while income elasticity is

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3 estimated at 0.19 and 0.40, respectively. Advertising had a positive but non-significant effect  
4 on demand and antismoking campaigns had a negative but non-significant effect on  
5 demand.[23] On the other hand, health warnings on packs during 1987-1990 had a  
6 significant negative impact on demand, lowering consumption by 4.2%. Dritsakis notes that  
7 consumption is a negative function of price and health education expenditure and a positive  
8 function of income as well.[24]  
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16 As illustrated, there are no studies of price elasticity available for at least a decade. In the  
17 light of the above, the purpose of the present study was to investigate cigarette demand in  
18 Greece.  
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#### 24 **Method**

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26 The tobacco product used in analysis is cigarettes, widely accepted as the major tobacco  
27 product. In order to account for population growth, annual consumption per person over 15  
28 was preferred to aggregate annual consumption. The threshold age was set at 15, as youth  
29 smoking in Greece is considered substantial. Data on annual cigarette consumption are  
30 available from 1994 onwards (1994-2012) from the Greek Ministry of Finance.  
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38 As excise tax data were not available and MPPC (Most Popular Price Category) shows  
39 inconsistency due to pricing policy, the measure chosen to reflect price was the Weighted  
40 Average Price. Each pack consists of 20 cigarettes. The proxy used to deflate nominal into  
41 real prices was calculated by comparing real and nominal values of GDP (Gross Domestic  
42 Product) derived from World Bank. CPI (Consumer Price Index) was not selected as a proxy  
43 due to a change in calculations by Hellenic Statistical Authority in 1995, when General  
44 Harmonized Consumer Price Index was introduced. The base year set was 2005. Disposable  
45 income data were based at GDP. Again, the threshold age was set at 15. Deflation was not  
46 needed in that case, as real values were available. The base year set was 2005. Prior to 2008,  
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national informative campaigns were not run in Greece at a national level. We considered The National Action Plan for Cancer (2008) as an anti-smoking campaign. A dummy variable was used to measure its influence on consumption. Expenditure on tobacco control was not available. Regulation for smoking bans and restrictions was only introduced in 2002 and amended in 2010. In order to measure its influence on consumption, an adjusted version of a previous reliable index was constructed, accounting not only for intensity of smoking restrictions but for compliance as well.[25] Values attributed were between 0 (no restrictions) to 1 (total ban) escalating by 0.25.

Data were analyzed with the statistical software packages SPSS® 20 and STATA® 9. The functional form used in the analysis was Double-log and values were transformed to natural logarithms in order to increase reliability. The models of demand were specified as follows.

*Conventional Demand Model*

$$\ln Q_t = b_0 + b_1 \ln P_t + b_2 \ln Y_t + b_3 SR_t + b_4 AsC_t + \varepsilon_t$$

*Myopic Addiction Model*

$$\ln Q_t = b_0 + b_1 \ln P_t + b_2 \ln Y_t + b_3 SR_t + b_4 AsC_t + b_5 \ln Q_{t-1} + \varepsilon_t$$

*Rational Addiction Model*

$$\ln Q_t = b_0 + b_1 \ln P_t + b_2 \ln Y_t + b_3 SR_t + b_4 AsC_t + b_5 \ln Q_{t-1} + b_6 \ln Q_{t+1} + \varepsilon_t$$

Where,

$Q_t$  : consumption of cigarettes per person over 15 (000 cigarettes) in year t

$Q_{t-1}$  : consumption of cigarettes per person over 15(000 cigarettes) in year t-1

$Q_{t+1}$  : consumption of cigarettes per person over 15(000 cigarettes) in year t+1

$P_t$  : real retail price per pack of 20 cigarettes in year t

$Y_t$ : real per person over 15 disposable income (€000) in year t



$b_0$ : intercept in year t

$SR_t$ : index of smoking restrictions or bans according to law in year t

$AsC_t$ : dichotomous index reflecting the existence of an anti-smoking campaign each year t

$\epsilon_t$ : the error term

## Results

Through the conventional model of demand, the demand equation was estimated as follows

(Table 2):

Table 2: Conventional model of demand equation

$\ln Q_t = -1.757 - 0.441 \cdot \ln P_t + 1.040 \cdot \ln Y_t - 0.132 \cdot AsC_t$		
F-statistic: 27.765	R square: 0.847	Durbin-Watson: 1.980
Skewness/Kurtosis tests for Normality: adj $\chi^2 = 5.10$ , Prob> $\chi^2 = 0.0780$		
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity: $\chi^2 = 2.56$ , Prob> $\chi^2 = 0.1093$		
Dickey-Fuller test for unit root: Z(t)= -2.364, 1% critical value=-2.660, 5% critical value= -1.950, 10% critical value=-1.600		

A regression analysis was performed and calculations were made stepwise. The variable created to capture the effect of smoking restrictions was found non-significant (p value asymptotically equal to 0.303 at 5% confidence level); thus, it is excluded from the model. P value at 5% confidence level is asymptotically equal to 0 for  $\ln Y_t$ , equal to 0.001 for  $\ln P_t$  and equal to 0.021 for  $AsC_t$ . The F-statistic is high, showing a good level of fit, while the model explains a great part of the variation. The Durbin-Watson statistic is close to 2, suggesting that the model has no autocorrelation. The Variation Inflated Factor is low for all variables, implying that multicollinearity is a non-factor. As evidenced by normality tests, standardized

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3 residuals follow a normal distribution. Breusch-Pagan / Cook-Weisberg tests indicate that  
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5 residuals are homoscedastic. The Augmented Dickey-Fuller test for standardized residuals  
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7 confirms that there exist no unit roots. Therefore, the standardized residuals are stationary,  
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9 so the variables of the model are cointegrated (without constant and trend) and the  
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11 regression is not spurious. In the light of the above, we accept a short-run price elasticity of  
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13 demand at 0.441 and a short-run income elasticity of demand at 1.040.  
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17 Through the myopic addiction model, the additional variable ( $\ln Q_{t-1}$ ) shows no statistical  
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19 significance. Therefore the model remains unchanged. Through the rational addiction  
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21 model, only the variable representing following year's consumption ( $\ln Q_{t+1}$ ) is found  
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23 significant (p value asymptotically equal to 0), with substantially lower levels of fit (R  
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25 square). Thus, we conclude that addiction models fail to offer additional information on how  
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27 consumption is influenced. Based on 2010 data, nominal tax revenue per pack is calculated  
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29 at €2.78, a value verifying and corresponding to the fixed amount of tax (86% of the nominal  
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31 retail price). We assume that the state maintains the existing ability to collect tribute.  
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33 Government proclamations suggest that tobacco will be further taxed. Therefore, we  
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35 distinct four scenarios, all with retail price increases, as anticipated, and each suggesting an  
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37 additional price increase by €0.5. Calculations are made only for the following year and  
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39 accordingly only short run elasticity is taken into account. Scenarios capture the impact of  
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41 the continuing fall in income at a rate of 4.8%. Based on Ross et al methodology and data  
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43 concerning tobacco-related mortality in Greece (Lower respiratory infections, Malignant  
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45 neoplasms, Cardiovascular diseases and Respiratory diseases), we estimate reduction on  
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47 smokers and mortality averted.[3,26]  
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Table 3: Impact of price increase and income constraints on consumption, tax revenue, number of smokers and smoking related deaths

Model scenarios	Scenario 1	Scenario 2	Scenario 3	Scenario 4	
Price per pack	€4.47	€4.97	€5.47	€5.97	
Percent increase of price	12.59%	25.19%	37.78%	50.38%	
Fall in consumption due to price increase	-5.55%	-11.11%	-16.66%	-22.22%	
Fall in consumption due to income decrease	-4.99%	-4.99%	-4.99%	-4.99%	
Per capita consumption level	1,779.84	1,669.33	1,558.82	1,448.31	
Per capita consumption deterred	209.83	320.34	430.85	541.36	
Tax revenue per pack	€3.84	€4.27	€4.70	€5.13	
Tax revenue per cigarette	€0.192	€0.214	€0.235	€0.257	
Total tax revenue (€ billion)	€3,336	€3,478	€3,575	€3,625	
Incremental tax revenue (€ billion)	€0,455	€0,597	€0,694	€0,744	
Reduction in number of smokers	205,650	313,956	422,262	530,568	
Smoking related deaths averted	high(0,50)	930	1,420	1,911	2,401
	low(0,25)	465	710	955	1,200

*-Differences in calculations may occur due to rounding*

*-Impact of price increase shared between prevalence and consumption*

*-High estimate indicates that 50% of smokers' deaths are attributable to tobacco use, whereas low estimate indicates that 25% of smokers' deaths are attributable to tobacco use*

In all four scenarios, consumption is decreased substantially while tax revenue is still increased thanks to the inelastic demand. Moreover, smokers are significantly reduced and smoking related deaths are accordingly limited.

### Discussion

Price elasticity estimates are greater than previous research in Greece,[8, 23-24] but consistent with findings by Gallet and List.[20] Estimates for income elasticity are far greater than estimates provided by literature in Greece.[8, 21-23] Regarding antismoking campaigns, results are in agreement with previous testimony.[23-24] Smoking restrictions show no statistical significance, confirming the claims by Joosens and Raw that compliance is low.[17] Finally, results are in general agreement with Alpert et al,[27] though a different methodology is followed.

Paired with the still high cigarette affordability, as documented in the current study and reported by previous research,[6] the nature of demand in Greece presents a vast opportunity for the policy makers to counter the tobacco epidemic and ensure revenue and cash flows at the same time. Even supposing that other determinants of demand, such as income, which is anticipated to fall, do not change, tobacco taxation proves to be a powerful tool. Annual consumption per person over 15 would be no higher than 1,780 cigarettes, even in the worst case (scenario1) and may fall to less than 1,448 cigarettes. On the other hand, tax revenue would recover from the downwards trend, accounting again for more than 1.80% of GDP, even in scenario1. In absolute values, excess tobacco tax revenue could rejuvenate the dismantled public coffers. Results suggest that even with a modest 10% of tax revenue allocated to offsetting the tobacco epidemic, there would be more than enough disposable funds towards planning, implementing, evaluating and improving antismoking efforts. Greeks seem to be in agreement with heavy taxation on cigarettes, but only if respective revenue is attributed to tobacco control.[28] In terms of public health benefits, smokers could be reduced by nearly 530,568 people, while up to 2,401 smoking related deaths could be averted on an annual basis. Nonetheless, findings should be treated with caution and increases in price should not be excessively increased from day one, as the

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3 smokers' reaction is not easy to predict with confidence intervals widened. A stepwise  
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5 increase of tax would eliminate many of the risks associated with a sharp and sudden  
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7 increase in cigarette prices. Besides, Greece already performs better in tax collection than  
8  
9 countries such as Germany, France and Slovenia among others,[26] as the excise per smoker  
10  
11 ratio indicates, with €738.71 collected for every smoker.  
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14 Income sensitivity is larger than in any previous study either in Greece or internationally.  
15  
16 Thus, it is not exaggerating to argue that Greek smokers are shocked by the constraint on  
17  
18 their income. Besides, it is the first time in at least 40 years that income in Greece is falling at  
19  
20 this rate. The austerity measures should be viewed as a shift event in cigarette consumption,  
21  
22 among others.  
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24  
25 Reducing the toll of tobacco in Greece is not an easy task. Decisions should include fostering  
26  
27 an antismoking-culture through well-planned national antismoking campaigns, raising the  
28  
29 cigarettes prices at an initial level no less than €4 a pack and ensuring compliance with the  
30  
31 anti-smoking law, especially on the current occasion, when City Police (the main mechanism  
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33 of control on the matter) was recently abolished as an institution. Controlling illicit trade is  
34  
35 crucial to maximize the effect of interventions.  
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39 As regards to the limitations of this study, it must be noted that addictions models were  
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41 unable to provide statistically significant information, possibly due to the inclusion of 2012  
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43 data in the time series. Possible future analysis of an even wider time series could provide  
44  
45 even more reliable results, as multicollinearity could be fully cured. Furthermore, the study  
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47 could be strengthened by employing statistical tests on more observations, regarding the  
48  
49 endogeneity of cigarette prices. Moreover, the current study is based on the most popular  
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51 price category in order to estimate the impact of prices changes on cigarette demand. It is  
52  
53 possible that a weighted average for all the brands sold in Greece could eliminate  
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55 unilateralism on prices data. Still, the anticipated but not fully documented switch of Greek  
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3 smokers from manufactured cigarettes to hand-rolled tobacco should be taken into account  
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5 in any future research. Yet, if the increase of contraband cigarettes in the Greek market  
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7 could be quantified, results would be more punctual. In addition, tobacco shows synergistic  
8  
9 effect with other substances, such as alcohol. Thus, it would be meaningful to investigate  
10  
11 the combined effect of tobacco and alcohol from an economic aspect. Finally, researchers  
12  
13 argue that the increased availability of nicotine substitutes will reduce demand for tobacco  
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15 products and increase the price sensitivity as well.[19] Under that scope, if research included  
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17 nicotine substitutes, accuracy would be improved.  
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4  
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6  
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8  
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10

11  
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13  
14 reported in the text. FT and KA reviewed the literature for relevant data and documentation.  
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16 FT and KA drafted the manuscript which was edited and critically revised by KA, AV and IK.  
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**Estimates of price and income elasticity in Greece:**

**Greek debt crisis transforming cigarettes into a luxury good - an econometric approach**

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**Abstract**

**Objective:** During the past decades, smoking prevalence in Greece was estimated near or over 40%. Following a sharp fall in newest data on cigarette consumption, our objective is to

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6 assess smokers' sensitivity to cigarette price and consumer income changes as well as to  
7 project health benefits of an additional tax increase.  
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10 **Methods:** Cigarette consumption was considered as the dependent variable, with Weighted  
11 Average Price as a proxy for cigarette price, GDP as a proxy for consumers' income and  
12 dummy variables reflecting smoking restrictions and antismoking campaigns. Values were  
13 computed to natural logarithms and regression was performed. Then, 4 scenarios of tax  
14 increase were distinguished in order to calculate potential health benefits.  
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21 **Results:** ~~Addiction models were unable to provide statistically significant information due to~~  
22 ~~a nearly 23.5% drop in consumption during 2012.~~ Short-run price elasticity is estimated at -  
23 0.441 and short-run income elasticity is estimated at 1.040. Antismoking campaigns were  
24 found to have a statistically significant impact on consumption. Results indicate that,  
25 depending on the level of tax increase, annual per capita consumption could fall by at least  
26 209.83 cigarettes; tax revenue could rise up by more than €0.74 billion, while smokers could  
27 be reduced by up to 530,568 and at least 465 smoking related deaths could be averted.  
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35 **Conclusions:** Price elasticity estimates are similar to previous studies in Greece, while  
36 income elasticity estimates are far greater. With cigarettes regarded as a luxury good, a  
37 great opportunity is presented for decision-makers to counter smoking. Increased taxation,  
38 along with focused antismoking campaigns, law reinforcement (to ensure compliance with  
39 smoking bans) and intensive control for smuggling could invoke a massive blow to the  
40 tobacco epidemic in Greece.  
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47 **Article Summary Strengths and limitations of this study**

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- The article offers information to policy makers regarding price elasticity, a key measure to perform tobacco control policy

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- The article reports, for the first time, an income elasticity above 1, as evidence that cigarettes tend to be considered a luxury good in Greece
- The analysis treats qualitative variables and projects health and financial benefits under extreme austerity
- The analysis could not include dynamic (addiction) models, as no statistical significance was reported

## Introduction

### Country Profile

Globally, more than 5 million people die every year from tobacco use, while tobacco use is the second leading cause of death, representing the 8.7% of global annual mortality .[1] As global tobacco consumption in 2009 was estimated at 5884 billion cigarettes,[2] tobacco clearly reflects the global transition from traditional risks such as undernutrition, unsafe sex, unsafe water, poor sanitation and hygiene to modern risks like physical inactivity, behavior risks and air quality.[1] In Greece, WHO estimations attribute 17% of mortality for people aged 30 or more to smoking.[3] Death rate attributed to tobacco and the proportion of deaths attributable to tobacco for ages 30 and over is documented in the following table (Table 1).

Table 1: Estimated death rated (per 100.000) and proportion attributable to tobacco for ages 30 and over, 2004 in Greece [3]

Cause of death	Death rate attributed to tobacco	Proportion of deaths attributable to tobacco
Lower respiratory infections	3	23%
Malignant neoplasms	110	29%
Cardiovascular diseases	90	12%
Respiratory diseases	23	37%

Little less than half Greek citizens (41%) are smokers.[4] Youth smoking is also high, 11.3% for young men and 9% for young women.[2] Environmental Tobacco Smoke (ETS) also represents a serious problem in Greece, as documented by previous research.[5]

Concerning cigarette affordability, findings suggest that Greece is one of the few high-income European Union countries with relatively low cigarette prices.[6] Low prices can be recognized as a factor for the tobacco epidemic in Greece.[7] According to own calculations,

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6 for the period 1992-2012, cigarette affordability, defined as the percentage of income  
7 needed to purchase 100 packs of cigarettes, was estimated from 0.56% to 1.98%.

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10 The first organized efforts to counter smoking in Greece were observed during 1979-1982.  
11  
12 At the moment, in Greece, tobacco advertising bans are complete, except for point-of-sale  
13  
14 advertising.

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17 Tax revenue from tobacco products is arguably very important for the economic policy. In  
18  
19 1990, tax revenue accounted for 4.4% of GDP.[8] For the period 1998-2010 tobacco tax  
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21 revenue stood for an annual average 2% of GDP, but it seems to follow a downwards trend.

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23  
24 Official estimates measure the total annual direct cost of smoking a €2.14 billion, in an  
25  
26 environment where debt crisis and austerity measures set serious constraints to the health  
27  
28 system and resources should, now more than ever, be allocated properly. [9] Tobacco's  
29  
30 unfavorable consequences on the poor could become a factor, where unemployment rates  
31  
32 are estimated at 27.1% for the 2<sup>nd</sup> quarter of 2013, continuing to grow from under 900,000  
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34 to approximately 1,350,000 people in the last 24 months.[10] Moreover, 31% of the total  
35  
36 population is at risk of poverty or social exclusion.[11]

### 37 38 Tobacco Market and government interventions

39  
40 Three market failures differentiate an individual's choice to smoke compared to the decision  
41  
42 to consume other goods: information failure on the health hazard of smoking, information  
43  
44 failure on the addiction caused by smoking and external burden to non-smokers.[12]  
45  
46 Therefore, government intervention is justified in order both to protect smokers from the  
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48 perilous habit and correct for externalities associated to smoking. From a basic economics'  
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50 standpoint, it can be claimed that smoking's immense social burden overtakes the loss of  
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52 consumer's utility or else the loss of economic efficiency (deadweight loss). -A hypothetical  
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example on how the deadweight loss emerges, after the introduction of tax, is illustrated in figures (Figure 1 and Figure 2).

Tobacco taxation is imposed through a variety of structures but, in nearly all cases, includes two main types of tax: Ad valorem tax, which represents a percentage of price and specific tax, which is a fixed tax per cigarette. In Greece, following the 2010 restructure of tobacco tax, total tax represents 86% of the retail price, significantly increased compared to the 2009 level and 2008 level when is represented 83% and 70% of the retail price respectively (WHO, 2011). In 2012, specific excise tax was regulated at €80 per 1,000 cigarettes and ad valorem tax at 20% of the retail price. Their minimum sum is required to be no less than €115 per 1,000 cigarettes. Meanwhile, a specific excise tax was set at €153 per kg of hand-rolled tobacco. Sales tax for cigarettes is fixed at 23% of the retail price.

Price increases should not be regarded the only way to reduce consumption, as the impact of income, advertising and health education are also important.[13] Manipulating these variables will result to reduced consumption and eventually reduced mortality and morbidity. Tobacco control programs and policies are found to be either cost-saving or cost-effective, compared to other public health interventions such as cardiovascular risk counseling and cancer screening.[14] Research on the impact of tobacco control showed that during 1981-2000, increases in tobacco control program expenditures in the U.S.A. lead to reduced cigarettes sales. Authors also suggest that expenditures have an even stronger lagged influence on sales.[15] Smoking bans are adopted in order to limit exposure to smoke but also cause a remarkable decrease in cigarette consumption, as smokers' opportunities to smoke are lessened.[16] In Greece, the effort to restrict smoking in public places through legislation has failed due to low compliance with law.[17] Youth exposed to secondhand smoke at home are estimated at 89.8% of total youth population.[2] Public education campaigns, if "hard-hitting, sophisticated and sustained", can be extremely effective.[18]



### Price and income elasticities

The term used to measure the impact of a change in price on consumption is price elasticity of demand, defined as the percentage change in consumption that results from 1 percent increase in price.[19] Similarly, the impact of a change in income on consumption is measured by income elasticity, defined as the percentage change in consumption resulting from 1 percent increase in income. Estimating elasticity is crucial to policy makers in order not only to anticipate an intervention's impact both on tobacco consumption and tobacco tax revenue. If the proportionate fall in tobacco consumption exceeds the proportionate increase of tax, revenue will fall. Otherwise, revenue will rise.[16]

Results from a meta-analysis,[20] indicate that short run elasticity (-0.40) is lower than long run elasticity (-0.44), while in studies that included smuggling demand was less sensitive (-0.36). These findings confirm the general notion that a 10% increase in price would lead to a 4% reduction in consumption in high-income countries.[18] Stavrinou estimated the short run price elasticity at -0.079 and the long run at -0.147, while income elasticity is estimated at 0.18 and 0.33, respectively.[21] Hondroyannis and Papapetrou, based on data over the period 1967-1990, calculated the short run price elasticity at -0.33 and the long run at -0.6, while income elasticity estimations are 0.35 and 0.54, respectively. The fact that demand is inelastic is explained by the authors through addiction and the absence of direct substitutes. Furthermore, it is claimed that health warnings are more effective in reducing consumption than price increases.[9] Raptou and colleagues conclude in an income elasticity of 0.28, consisting of initiation elasticity (0.21) and consumption elasticity (0.07), arguing that income is a more important determinant for initiation rather than consumption. Furthermore, smoking bans are illustrated as a factor discouraging tobacco consumption.[22] Nikolaou and Velentzas, based on data from 1960 to 1995, estimated the short run price elasticity at -0.24 and the long run at -0.48, while income elasticity is

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6 estimated at 0.19 and 0.40, respectively. Advertising had a positive but non-significant effect  
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8 on demand and antismoking campaigns had a negative but non-significant effect on  
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10 demand.[23] On the other hand, health warnings on packs during 1987-1990 had a  
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12 significant negative impact on demand, lowering consumption by 4.2%. Draitsakis notes that  
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14 consumption is a negative function of price and health education expenditure and a positive  
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16 function of income as well.[24]

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18 As illustrated, there are no studies of price elasticity available for at least a decade. In the  
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20 light of the above, the purpose of the present study was to investigate cigarette demand in  
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22 Greece.

### 23 24 **Method**

25  
26 The tobacco product used in analysis is cigarettes, widely accepted as the major tobacco  
27  
28 product. In order to account for population growth, annual consumption per person over 15  
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30 was preferred to aggregate annual consumption. The threshold age was set at 15, as youth  
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32 smoking in Greece is considered substantial. Data on annual cigarette consumption are  
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34 available from 1994 onwards [\(1994-2012\) from the Greek Ministry of Finance](#).

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37 ~~Monthly (and quarterly) data on the quantities of taxed cigarettes were available from 2007~~  
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39 ~~to 2011.~~ As excise tax data were not available and MPPC (Most Popular Price Category)  
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41 shows inconsistency due to pricing policy, the measure chosen to reflect price was the  
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43 Weighted Average Price. Each pack consists of 20 cigarettes. The proxy used to deflate  
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45 nominal into real prices was calculated by comparing real and nominal values of GDP (Gross  
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47 Domestic Product) derived from World Bank. CPI (Consumer Price Index) was not selected as  
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49 a proxy due to a change in calculations by Hellenic Statistical Authority in 1995, when  
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51 General Harmonized Consumer Price Index was introduced. The base year set was 2005.  
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53 Disposable income data were based at GDP. Again, the threshold age was set at 15.  
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Deflation was not needed in that case, as real values were available. The base year set was 2005. Prior to 2008, national informative campaigns were not run in Greece at a national level. We considered The National Action Plan for Cancer (2008) as an anti-smoking campaign. A dummy variable was used to measure its influence on consumption. Expenditure on tobacco control was not available. Regulation for smoking bans and restrictions was only introduced in 2002 and amended in 2010. In order to measure its influence on consumption, an adjusted version of a previous reliable index was constructed, accounting not only for intensity of smoking restrictions but for compliance as well.[25] Values attributed were between 0 (no restrictions) to 1 (total ban) escalating by 0.25.

~~Regression analysis includes only a static model, as dynamic models (incorporating models) show limited statistical significance, due to the inclusion of 2012 data in the time series.~~

~~Data were analyzed with the statistical software packages SPSS® 20 and STATA® 9. The functional form used in the analysis was Double-log and values were transformed to natural logarithms in order to increase reliability. Testing for endogeneity of cigarette prices was not possible as the annual tax rates were only available from 2008 onwards. Time trend was found to be insignificant; therefore, it is excluded from the equations. The models of demand was were specified as follows.~~

#### *Conventional Demand Model*

$$\ln Q_t = b_0 + b_1 \ln P_t + b_2 \ln Y_t + b_3 SR_t + b_4 ASC_t + \varepsilon_t$$

#### *Myopic Addiction Model*

$$\ln Q_t = b_0 + b_1 \ln P_t + b_2 \ln Y_t + b_3 SR_t + b_4 ASC_t + b_5 \ln Q_{t-1} + \varepsilon_t$$

#### *Rational Addiction Model*

$$\ln Q_t = b_0 + b_1 \ln P_t + b_2 \ln Y_t + b_3 SR_t + b_4 ASC_t + b_5 \ln Q_{t-1} + b_6 \ln Q_{t+1} + \varepsilon_t$$

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6  $Q_t$  : consumption of cigarettes per person over 15 (000 cigarettes) in year t  
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9  $Q_{t-1}$  : consumption of cigarettes per person over 15(000 cigarettes) in year t-1

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11  $Q_{t+1}$  : consumption of cigarettes per person over 15(000 cigarettes) in year t+1

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13  $P_t$  : real retail price per pack of 20 cigarettes in year t  
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16  $Y_t$  : real per person over 15 disposable income (€000-€) in year t  
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19  $b_0$  : intercept in year t  
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21  $SR_t$  : index of smoking restrictions or bans according to law in year t  
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24  $AsC_t$  : dummy checking dichotomous index reflecting the existence of an anti-smoking  
25 campaign each year t  
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28  $\varepsilon_t$  : the error term  
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## Results

Through the conventional model of demand, the demand equation was estimated as follows

(Table 2):

Table 2: Conventional model of demand equation

$\ln Q_t = -1.757 - 0.441 \cdot \ln P_t + 1.040 \cdot \ln Y_t - 0.132 \cdot \text{AsC}_t$		
F-statistic: 27.765	R square: 0.847	Durbin-Watson: 1.980
Skewness/Kurtosis tests for Normality: adj chi <sup>2</sup> = 5.10, Prob>chi <sup>2</sup> = 0.0780		
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity: chi <sup>2</sup> = 2.56, Prob>chi <sup>2</sup> = 0.1093		
Dickey-Fuller test for unit root: Z(t) = -2.364, 1% critical value = -2.660, 5% critical value = -1.950, 10% critical value = -1.600		

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A regression analysis was performed and calculations were made stepwise. The variable created to capture the effect of smoking restrictions was found non-significant (p value asymptotically equal to 0.303 at 5% confidence level); thus, it is excluded from the model. P value at 5% confidence level is asymptotically equal to 0 for  $\ln Y_t$ , equal to 0.001 for  $\ln P_t$  and equal to 0.021 for  $\text{AsC}_t$ . The F-statistic is high, showing a good level of fit, while the model explains a great part of the variation. The Durbin-Watson statistic is close to 2, suggesting that the model has no autocorrelation. The Variation Inflated Factor is low for all variables, implying that multicollinearity is a non-factor. As evidenced by normality tests, standardized residuals follow a normal distribution. Breusch-Pagan / Cook-Weisberg tests indicate that residuals are homoscedastic. The Augmented Dickey-Fuller test for standardized residuals confirms that there exist no unit roots. Therefore, the standardized residuals are stationary, so the variables of the model are cointegrated (without constant and trend) and the

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6 regression is not spurious. In the light of the above, we accept a short-run price elasticity of  
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8 demand at 0.441 and a short-run income elasticity of demand at 1.040.

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11 Through the myopic addiction model, the additional variable ( $\ln Q_{t-1}$ ) shows no statistical  
12 significance. Therefore the model remains unchanged. Through the rational addiction  
13 model, only the variable representing following year's consumption ( $\ln Q_{t+1}$ ) is found  
14 significant (p value asymptotically equal to 0), with substantially lower levels of fit (R  
15 square). Thus, we conclude that addiction models fail to offer additional information on how  
16 consumption is influenced.

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20 Based on 2010 data, nominal tax revenue per pack is calculated at €2.78, a value verifying  
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22 and corresponding to the fixed amount of tax (86% of the nominal retail price). We assume  
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24 that the state maintains the existing ability to collect tribute. Government proclamations  
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26 suggest that tobacco will be further taxed. Therefore, we distinct four scenarios, all with  
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28 retail price increases, as anticipated, and each suggesting an additional price increase by  
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30 €0.5. Calculations are made only for the following year and accordingly only short run  
31  
32 elasticity is taken into account. Scenarios capture the impact of the continuing fall in income  
33  
34 at a rate of 4.8%. Based on Ross et al methodology and data concerning tobacco-related  
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36 mortality in Greece (Lower respiratory infections, Malignant neoplasms, Cardiovascular  
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38 diseases and Respiratory diseases), we estimate reduction on smokers and mortality  
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40 averted.[3,26]  
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Table 32: Impact of price increase and income constraints on consumption, tax revenue, number of smokers and smoking related deaths

Model scenarios	Scenario 1	Scenario 2	Scenario 3	Scenario 4	
Price per pack	€4.47	€4.97	€5.47	€5.97	
Percent increase of price	12.59%	25.19%	37.78%	50.38%	
Fall in consumption due to price increase	-5.55%	-11.11%	-16.66%	-22.22%	
Fall in consumption due to income decrease	-4.99%	-4.99%	-4.99%	-4.99%	
Per capita consumption level	1,779.84	1,669.33	1,558.82	1,448.31	
Per capita consumption deterred	209.83	320.34	430.85	541.36	
Tax revenue per pack	€3.84	€4.27	€4.70	€5.13	
Tax revenue per cigarette	€0.192	€0.214	€0.235	€0.257	
Total tax revenue (€ billion)	€3,336	€3,478	€3,575	€3,625	
Incremental tax revenue (€ billion)	€0,455	€0,597	€0,694	€0,744	
Reduction in number of smokers	205,650	313,956	422,262	530,568	
Smoking related deaths averted	high(0,50)	930	1,420	1,911	2,401
	low(0,25)	465	710	955	1,200

-Differences in calculations may occur due to rounding

-Impact of price increase shared between prevalence and consumption

-High estimate indicates that 50% of smokers' deaths are attributable to tobacco use, whereas low estimate indicates that 25% of smokers' deaths are attributable to tobacco use

In all four scenarios, consumption is decreased substantially while tax revenue is still increased thanks to the inelastic demand. Moreover, smokers are significantly reduced and smoking related deaths are accordingly limited.

## Discussion

Price elasticity estimates are greater than previous research in Greece,[8, 23-24] but consistent with findings by Gallet and List.[20] Estimates for income elasticity are far greater than estimates provided by literature in Greece.[8, 21-23] Regarding antismoking campaigns, results are in agreement with previous testimony.[23-24] Smoking restrictions show no statistical significance, confirming the claims by Joosens and Raw that compliance is low.[17] Finally, results are in general agreement with Alpert et al,[27] though a different methodology is followed.

Paired with the still high cigarette affordability, as documented in the current study and reported by previous research,[6] the nature of demand in Greece presents a vast opportunity for the policy makers to counter the tobacco epidemic and ensure revenue and cash flows at the same time. Even supposing that other determinants of demand, such as income, which is anticipated to fall, do not change, tobacco taxation proves to be a powerful tool. Annual consumption per person over 15 would be no higher than 1,780 cigarettes, even in the worst case (scenario1) and may fall to less than 1,448 cigarettes. On the other hand, tax revenue would recover from the downwards trend, accounting again for more than 1.80% of GDP, even in scenario1. In absolute values, excess tobacco tax revenue could rejuvenate the dismantled public coffers. Results suggest that even with a modest 10% of tax revenue allocated to offsetting the tobacco epidemic, there would be more than enough disposable funds towards planning, implementing, evaluating and improving antismoking efforts. Greeks seem to be in agreement with heavy taxation on cigarettes, but only if respective revenue is attributed to tobacco control.[28] In terms of public health benefits, smokers could be reduced by nearly 530,568 people, while up to 2,401 smoking related deaths could be averted on an annual basis. Nonetheless, findings should be treated with caution and increases in price should not be excessively increased from day one, as the



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6 smokers' reaction is not easy to predict with confidence intervals widened. A stepwise  
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8 increase of tax would eliminate many of the risks associated with a sharp and sudden  
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10 increase in cigarette prices. Besides, Greece already performs better in tax collection than  
11  
12 countries such as Germany, France and Slovenia among others,[26] as the excise per smoker  
13  
14 ratio indicates, with €738.71 collected for every smoker.

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16 Income sensitivity is larger than in any previous study either in Greece or internationally.  
17  
18 Thus, it is not exaggerating to argue that Greek smokers are shocked by the constraint on  
19  
20 their income. Besides, it is the first time in at least 40 years that income in Greece is falling at  
21  
22 this rate. The austerity measures should be viewed as a shift event in cigarette consumption,  
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24 among others.

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26 Reducing the toll of tobacco in Greece is not an easy task. Decisions should include fostering  
27  
28 an antismoking-culture through well-planned national antismoking campaigns, raising the  
29  
30 cigarettes prices at an initial level no less than €4 a pack and ensuring compliance with the  
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32 anti-smoking law, especially on the current occasion, when City Police (the main mechanism  
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34 of control on the matter) was recently abolished as an institution. Controlling illicit trade is  
35  
36 crucial to maximize the effect of interventions.

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39 As regards to the limitations of this study, it must be noted that addictions models were  
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41 unable to provide statistically significant information, possibly due to the inclusion of 2012  
42  
43 data in the time series. Possible future analysis of an even wider time series could provide  
44  
45 even more reliable results, as multicollinearity could be fully cured. Furthermore, the study  
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47 could be strengthened by employing statistical tests on more observations, regarding the  
48  
49 endogeneity of cigarette prices. Moreover, the current study is based on the most popular  
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51 price category in order to estimate the impact of prices changes on cigarette demand. It is  
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53 possible that a weighted average for all the brands sold in Greece could eliminate  
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55 unilateralism on prices data. Still, the anticipated but not fully documented switch of Greek  
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6 smokers from manufactured cigarettes to hand-rolled tobacco should be taken into account  
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8 in any future research. Yet, if the increase of contraband cigarettes in the Greek market  
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10 could be quantified, results would be more punctual. In addition, tobacco shows synergistic  
11  
12 effect with other substances, such as alcohol. Thus, it would be meaningful to investigate  
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14 the combined effect of tobacco and alcohol from an economic aspect. Finally, researchers  
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16 argue that the increased availability of nicotine substitutes will reduce demand for tobacco  
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18 products and increase the price sensitivity as well.[19] Under that scope, if research included  
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20 nicotine substitutes, accuracy would be improved.  
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6 **Contributorship Statement:** FT, [DZ](#) and AV performed the calculations and analyses  
7 reported in the text. FT and KA reviewed the literature for relevant data and documentation.  
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10 FT and KA drafted the manuscript which was edited and critically revised by KA, [AV](#) and IK.  
11

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6 **Figures**  
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9 **Figure 1: The demand curve before government intervention**  
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12 **Figure 2: The demand curve after government intervention**  
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# BMJ Open

## Estimates of price and income elasticity in Greece: Greek debt crisis transforming cigarettes into a luxury good - an econometric approach

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3 **Estimates of price and income elasticity in Greece:**  
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5 **Greek debt crisis transforming cigarettes into a luxury good - an econometric approach**  
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## **Abstract**

**Objective:** During the past decades, smoking prevalence in Greece was estimated near or over 40%. Following a sharp fall in newest data on cigarette consumption, our objective is to assess smokers' sensitivity to cigarette price and consumer income changes as well as to project health benefits of an additional tax increase.

**Methods:** Cigarette consumption was considered as the dependent variable, with Weighted Average Price as a proxy for cigarette price, GDP as a proxy for consumers' income and dummy variables reflecting smoking restrictions and antismoking campaigns. Values were computed to natural logarithms and regression was performed. Then, 4 scenarios of tax increase were distinguished in order to calculate potential health benefits.

**Results:** Short-run price elasticity is estimated at -0.441 and short-run income elasticity is estimated at 1.040. Antismoking campaigns were found to have a statistically significant impact on consumption. Results indicate that, depending on the level of tax increase, annual per capita consumption could fall by at least 209.83 cigarettes; tax revenue could rise up by more than €0.74 billion, while smokers could be reduced by up to 530,568 and at least 465 smoking related deaths could be averted.

**Conclusions:** Price elasticity estimates are similar to previous studies in Greece, while income elasticity estimates are far greater. With cigarettes regarded as a luxury good, a great opportunity is presented for decision-makers to counter smoking. Increased taxation, along with focused antismoking campaigns, law reinforcement (to ensure compliance with smoking bans) and intensive control for smuggling could invoke a massive blow to the tobacco epidemic in Greece.

### Strengths and limitations of this study

- The article offers information to policy makers regarding price elasticity, a key measure to perform tobacco control policy
- The article reports, for the first time, an income elasticity above 1, as evidence that cigarettes tend to be considered a luxury good in Greece
- The analysis treats qualitative variables and projects health and financial benefits under extreme austerity
- The analysis could not include dynamic (addiction) models, as no statistical significance was reported

## Introduction

### Country Profile

Globally, more than 5 million people die every year from tobacco use, while tobacco use is the second leading cause of death, representing the 8.7% of global annual mortality .[1] As global tobacco consumption in 2009 was estimated at 5884 billion cigarettes,[2] tobacco clearly reflects the global transition from traditional risks such as undernutrition, unsafe sex, unsafe water, poor sanitation and hygiene to modern risks like physical inactivity, behavior risks and air quality.[1] In Greece, WHO estimations attribute 17% of mortality for people aged 30 or more to smoking.[3] Death rate attributed to tobacco and the proportion of deaths attributable to tobacco for ages 30 and over is documented in the following table (Table 1).

Table 1: Estimated death rated (per 100.000) and proportion attributable to tobacco for ages 30 and over, 2004 in Greece [3]

Cause of death	Death rate attributed to tobacco	Proportion of deaths attributable to tobacco
Lower respiratory infections	3	23%
Malignant neoplasms	110	29%
Carciovascular diseases	90	12%
Respiratoty diseases	23	37%

Little less than half Greek citizens (41%) are smokers.[4] Youth smoking is also high, 11.3% for young men and 9% for young women.[2] Environmental Tobacco Smoke (ETS) also represents a serious problem in Greece, as documented by previous research.[5]

Concerning cigarette affordability, findings suggest that Greece is one of the few high-income European Union countries with relatively low cigarette prices.[6] Low prices can be

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3 recognized as a factor for the tobacco epidemic in Greece.[7] According to own calculations,  
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5 for the period 1992-2012, cigarette affordability, defined as the percentage of income  
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7 needed to purchase 100 packs of cigarettes, was estimated from 0.56% to 1.98%.

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10 The first organized efforts to counter smoking in Greece were observed during 1979-1982.  
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12 At the moment, in Greece, tobacco advertising bans are complete, except for point-of-sale  
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14 advertising.

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17 Tax revenue from tobacco products is arguably very important for the economic policy. In  
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19 1990, tax revenue accounted for 4.4% of GDP.[8] For the period 1998-2010 tobacco tax  
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21 revenue stood for an annual average 2% of GDP, but it seems to follow a downwards trend.  
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24  
25 Official estimates measure the total annual direct cost of smoking a €2.14 billion, in an  
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27 environment where debt crisis and austerity measures set serious constraints to the health  
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29 system and resources should, now more than ever, be allocated properly. [9] Tobacco's  
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31 unfavorable consequences on the poor could become a factor, where unemployment rates  
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33 are estimated at 27.1% for the 2<sup>nd</sup> quarter of 2013, continuing to grow from under 900,000  
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35 to approximately 1,350,000 people in the last 24 months.[10] Moreover, 31% of the total  
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37 population is at risk of poverty or social exclusion.[11]  
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#### 40 Tobacco Market and government interventions

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43 Three market failures differentiate an individual's choice to smoke compared to the decision  
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45 to consume other goods: information failure on the health hazard of smoking, information  
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47 failure on the addiction caused by smoking and external burden to non-smokers.[12]  
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50 Therefore, government intervention is justified in order both to protect smokers from the  
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52 perilous habit and correct for externalities associated to smoking. From a basic economics'  
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54 standpoint, it can be claimed that smoking's immense social burden overtakes the loss of  
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56 consumer's utility or else the loss of economic efficiency (deadweight loss).  
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3 Tobacco taxation is imposed through a variety of structures but, in nearly all cases, includes  
4 two main types of tax: Ad valorem tax, which represents a percentage of price and specific  
5 tax, which is a fixed tax per cigarette. In Greece, following the 2010 restructure of tobacco  
6 tax, total tax represents 86% of the retail price, significantly increased compared to the 2009  
7 level and 2008 level when is represented 83% and 70% of the retail price respectively (WHO,  
8 2011). In 2012, specific excise tax was regulated at €80 per 1,000 cigarettes and ad valorem  
9 tax at 20% of the retail price. Their minimum sum is required to be no less than €115 per  
10 1,000 cigarettes. Meanwhile, a specific excise tax was set at €153 per kg of hand-rolled  
11 tobacco. Sales tax for cigarettes is fixed at 23% of the retail price.

12  
13 Price increases should not be regarded the only way to reduce consumption, as the impact  
14 of income, advertising and health education are also important.[13] Manipulating these  
15 variables will result to reduced consumption and eventually reduced mortality and  
16 morbidity. Tobacco control programs and policies are found to be either cost-saving or cost-  
17 effective, compared to other public health interventions such as cardiovascular risk  
18 counseling and cancer screening.[14] Research on the impact of tobacco control showed  
19 that during 1981-2000, increases in tobacco control program expenditures in the U.S.A. lead  
20 to reduced cigarettes sales. Authors also suggest that expenditures have an even stronger  
21 lagged influence on sales.[15] Smoking bans are adopted in order to limit exposure to smoke  
22 but also cause a remarkable decrease in cigarette consumption, as smokers' opportunities to  
23 smoke are lessened.[16] In Greece, the effort to restrict smoking in public places through  
24 legislation has failed due to low compliance with law.[17] Youth exposed to secondhand  
25 smoke at home are estimated at 89.8% of total youth population.[2] Public education  
26 campaigns, if "hard-hitting, sophisticated and sustained", can be extremely effective.[18]

### Price and income elasticity

The term used to measure the impact of a change in price on consumption is price elasticity of demand, defined as the percentage change in consumption that results from 1 percent increase in price.[19] Similarly, the impact of a change in income on consumption is measured by income elasticity, defined as the percentage change in consumption resulting from 1 percent increase in income. Estimating elasticity is crucial to policy makers in order not only to anticipate an intervention's impact both on tobacco consumption and tobacco tax revenue. If the proportionate fall in tobacco consumption exceeds the proportionate increase of tax, revenue will fall. Otherwise, revenue will rise.[16]

Results from a meta-analysis,[20] indicate that short run elasticity (-0.40) is lower than long run elasticity (-0.44), while in studies that included smuggling demand was less sensitive (-0.36). These findings confirm the general notion that a 10% increase in price would lead to a 4% reduction in consumption in high-income countries.[18] Stavrinou estimated the short run price elasticity at -0.079 and the long run at -0.147, while income elasticity is estimated at 0.18 and 0.33, respectively.[21] Hondroyannis and Papapetrou, based on data over the period 1967-1990, calculated the short run price elasticity at -0.33 and the long run at -0.6, while income elasticity estimations are 0.35 and 0.54, respectively. The fact that demand is inelastic is explained by the authors through addiction and the absence of direct substitutes. Furthermore, it is claimed that health warnings are more effective in reducing consumption than price increases.[9] Raptou and colleagues conclude in an income elasticity of 0.28, consisting of initiation elasticity (0.21) and consumption elasticity (0.07), arguing that income is a more important determinant for initiation rather than consumption. Furthermore, smoking bans are illustrated as a factor discouraging tobacco consumption.[22] Nikolaou and Velentzas, based on data from 1960 to 1995, estimated the short run price elasticity at -0.24 and the long run at -0.48, while income elasticity is

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3 estimated at 0.19 and 0.40, respectively. Advertising had a positive but non-significant effect  
4 on demand and antismoking campaigns had a negative but non-significant effect on  
5 demand.[23] On the other hand, health warnings on packs during 1987-1990 had a  
6 significant negative impact on demand, lowering consumption by 4.2%. Dritsakis notes that  
7 consumption is a negative function of price and health education expenditure and a positive  
8 function of income as well.[24]  
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12 As illustrated, there are no studies of price elasticity available for at least a decade. In the  
13 light of the above, the purpose of the present study was to investigate cigarette demand in  
14 Greece.  
15

### 16 17 18 **Method**

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21 The tobacco product used in analysis is cigarettes, widely accepted as the major tobacco  
22 product. In order to account for population growth, annual consumption per person over 15  
23 was preferred to aggregate annual consumption. The threshold age was set at 15, as youth  
24 smoking in Greece is considered substantial. Data on annual cigarette consumption are  
25 available from 1994 onwards (1994-2012) from the Greek Ministry of Finance.  
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29 As excise tax data were not available and MPPC (Most Popular Price Category) shows  
30 inconsistency due to pricing policy, the measure chosen to reflect price was the Weighted  
31 Average Price. Each pack consists of 20 cigarettes. The proxy used to deflate nominal into  
32 real prices was calculated by comparing real and nominal values of GDP (Gross Domestic  
33 Product) derived from World Bank. CPI (Consumer Price Index) was not selected as a proxy  
34 due to a change in calculations by Hellenic Statistical Authority in 1995, when General  
35 Harmonized Consumer Price Index was introduced. The base year set was 2005. Disposable  
36 income data were based at GDP. Again, the threshold age was set at 15. Deflation was not  
37 needed in that case, as real values were available. The base year set was 2005. Prior to 2008,  
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national informative campaigns were not run in Greece at a national level. We considered The National Action Plan for Cancer (2008) as an anti-smoking campaign. A dummy variable was used to measure its influence on consumption. Expenditure on tobacco control was not available. Regulation for smoking bans and restrictions was only introduced in 2002 and amended in 2010. In order to measure its influence on consumption, an adjusted version of a previous reliable index was constructed, accounting not only for intensity of smoking restrictions but for compliance as well.[25] Values attributed were between 0 (no restrictions) to 1 (total ban) escalating by 0.25.

Data were analyzed with the statistical software packages SPSS® 20 and STATA® 9. The functional form used in the analysis was Double-log and values were transformed to natural logarithms in order to increase reliability. The models of demand were specified as follows.

*Conventional Demand Model*

$$\ln Q_t = b_0 + b_1 \ln P_t + b_2 \ln Y_t + b_3 SR_t + b_4 AsC_t + \varepsilon_t$$

*Myopic Addiction Model*

$$\ln Q_t = b_0 + b_1 \ln P_t + b_2 \ln Y_t + b_3 SR_t + b_4 AsC_t + b_5 \ln Q_{t-1} + \varepsilon_t$$

*Rational Addiction Model*

$$\ln Q_t = b_0 + b_1 \ln P_t + b_2 \ln Y_t + b_3 SR_t + b_4 AsC_t + b_5 \ln Q_{t-1} + b_6 \ln Q_{t+1} + \varepsilon_t$$

Where,

$Q_t$  : consumption of cigarettes per person over 15 (000 cigarettes) in year t

$Q_{t-1}$  : consumption of cigarettes per person over 15(000 cigarettes) in year t-1

$Q_{t+1}$  : consumption of cigarettes per person over 15(000 cigarettes) in year t+1

$P_t$  : real retail price per pack of 20 cigarettes in year t

$Y_t$ : real per person over 15 disposable income (€000) in year t

$b_0$ : intercept in year t

$SR_t$ : index of smoking restrictions or bans according to law in year t

$AsC_t$ : dichotomous index reflecting the existence of an anti-smoking campaign each year t

$\epsilon_t$ : the error term

## Results

Through the conventional model of demand, the demand equation was estimated as follows

(Table 2):

Table 2: Conventional model of demand equation

$\ln Q_t = -1.757 - 0.441 \cdot \ln P_t + 1.040 \cdot \ln Y_t - 0.132 \cdot AsC_t$		
F-statistic: 27.765	R square: 0.847	Durbin-Watson: 1.980
Skewness/Kurtosis tests for Normality: adj $\chi^2 = 5.10$ , Prob> $\chi^2 = 0.0780$		
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity: $\chi^2 = 2.56$ , Prob> $\chi^2 = 0.1093$		
Dickey-Fuller test for unit root: Z(t)= -2.364, 1% critical value=-2.660, 5% critical value= -1.950, 10% critical value=-1.600		

A regression analysis was performed and calculations were made stepwise. The variable created to capture the effect of smoking restrictions was found non-significant (p value asymptotically equal to 0.303 at 5% confidence level); thus, it is excluded from the model. P value at 5% confidence level is asymptotically equal to 0 for  $\ln Y_t$ , equal to 0.001 for  $\ln P_t$  and equal to 0.021 for  $AsC_t$ . The F-statistic is high, showing a good level of fit, while the model explains a great part of the variation. The Durbin-Watson statistic is close to 2, suggesting that the model has no autocorrelation. The Variation Inflated Factor is low for all variables, implying that multicollinearity is a non-factor. As evidenced by normality tests, standardized

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3 residuals follow a normal distribution. Breusch-Pagan / Cook-Weisberg tests indicate that  
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5 residuals are homoscedastic. The Augmented Dickey-Fuller test for standardized residuals  
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7 confirms that there exist no unit roots. Therefore, the standardized residuals are stationary,  
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9 so the variables of the model are cointegrated (without constant and trend) and the  
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11 regression is not spurious. In the light of the above, we accept a short-run price elasticity of  
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13 demand at 0.441 and a short-run income elasticity of demand at 1.040.  
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17 Through the myopic addiction model, the additional variable ( $\ln Q_{t-1}$ ) shows no statistical  
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19 significance. Therefore the model remains unchanged. Through the rational addiction  
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21 model, only the variable representing following year's consumption ( $\ln Q_{t+1}$ ) is found  
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23 significant (p value asymptotically equal to 0), with substantially lower levels of fit (R  
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25 square). Thus, we conclude that addiction models fail to offer additional information on how  
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27 consumption is influenced. Based on 2010 data, nominal tax revenue per pack is calculated  
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29 at €2.78, a value verifying and corresponding to the fixed amount of tax (86% of the nominal  
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31 retail price). We assume that the state maintains the existing ability to collect tribute.  
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33 Government proclamations suggest that tobacco will be further taxed. Therefore, we  
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35 distinct four scenarios, all with retail price increases, as anticipated, and each suggesting an  
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37 additional price increase by €0.5. Calculations are made only for the following year and  
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39 accordingly only short run elasticity is taken into account. Scenarios capture the impact of  
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41 the continuing fall in income at a rate of 4.8%. Based on Ross et al methodology and data  
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43 concerning tobacco-related mortality in Greece (Lower respiratory infections, Malignant  
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45 neoplasms, Cardiovascular diseases and Respiratory diseases), we estimate reduction on  
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47 smokers and mortality averted.[3,26]  
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52 In all four scenarios, consumption is decreased substantially while tax revenue is still  
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54 increased thanks to the inelastic demand. Moreover, smokers are significantly reduced and  
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56 smoking related deaths are accordingly limited (Table 3).  
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Table 3: Impact of price increase and income constraints on consumption, tax revenue, number of smokers and smoking related deaths

Model scenarios	Scenario 1	Scenario 2	Scenario 3	Scenario 4	
Price per pack	€4.47	€4.97	€5.47	€5.97	
Percent increase of price	12.59%	25.19%	37.78%	50.38%	
Fall in consumption due to price increase	-5.55%	-11.11%	-16.66%	-22.22%	
Fall in consumption due to income decrease	-4.99%	-4.99%	-4.99%	-4.99%	
Per capita consumption level	1,779.84	1,669.33	1,558.82	1,448.31	
Per capita consumption deterred	209.83	320.34	430.85	541.36	
Tax revenue per pack	€3.84	€4.27	€4.70	€5.13	
Tax revenue per cigarette	€0.192	€0.214	€0.235	€0.257	
Total tax revenue (€ billion)	€3,336	€3,478	€3,575	€3,625	
Incremental tax revenue (€ billion)	€0,455	€0,597	€0,694	€0,744	
Reduction in number of smokers	205,650	313,956	422,262	530,568	
Smoking related deaths averted	high(0,50)	930	1,420	1,911	2,401
	low(0,25)	465	710	955	1,200

*-Differences in calculations may occur due to rounding*

*-Impact of price increase shared between prevalence and consumption*

*-High estimate indicates that 50% of smokers' deaths are attributable to tobacco use, whereas low estimate indicates that 25% of smokers' deaths are attributable to tobacco use*

### Discussion

Price elasticity estimates are greater than previous research in Greece,[8, 23-24] but consistent with findings by Gallet and List.[20] Estimates for income elasticity are far greater than estimates provided by literature in Greece.[8, 21-23] Regarding antismoking campaigns, results are in agreement with previous testimony.[23-24] Smoking restrictions show no statistical significance, confirming the claims by Joosens and Raw that compliance is low.[17] Finally, results are in general agreement with Alpert et al,[27] though a different methodology is followed.

Paired with the still high cigarette affordability, as documented in the current study and reported by previous research,[6] the nature of demand in Greece presents a vast opportunity for the policy makers to counter the tobacco epidemic and ensure revenue and cash flows at the same time. Even supposing that other determinants of demand, such as income, which is anticipated to fall, do not change, tobacco taxation proves to be a powerful tool. Annual consumption per person over 15 would be no higher than 1,780 cigarettes, even in the worst case (scenario1) and may fall to less than 1,448 cigarettes. On the other hand, tax revenue would recover from the downwards trend, accounting again for more than 1.80% of GDP, even in scenario1. In absolute values, excess tobacco tax revenue could rejuvenate the dismantled public coffers. Results suggest that even with a modest 10% of tax revenue allocated to offsetting the tobacco epidemic, there would be more than enough disposable funds towards planning, implementing, evaluating and improving antismoking efforts. Greeks seem to be in agreement with heavy taxation on cigarettes, but only if respective revenue is attributed to tobacco control.[28] In terms of public health benefits, smokers could be reduced by nearly 530,568 people, while up to 2,401 smoking related deaths could be averted on an annual basis. Nonetheless, findings should be treated with caution and increases in price should not be excessively increased from day one, as the

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3 smokers' reaction is not easy to predict with confidence intervals widened. A stepwise  
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5 increase of tax would eliminate many of the risks associated with a sharp and sudden  
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7 increase in cigarette prices. Besides, Greece already performs better in tax collection than  
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9 countries such as Germany, France and Slovenia among others,[26] as the excise per smoker  
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11 ratio indicates, with €738.71 collected for every smoker.  
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14 Income sensitivity is larger than in any previous study either in Greece or internationally.  
15  
16 Thus, it is not exaggerating to argue that Greek smokers are shocked by the constraint on  
17  
18 their income. Besides, it is the first time in at least 40 years that income in Greece is falling at  
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20 this rate. The austerity measures should be viewed as a shift event in cigarette consumption,  
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22 among others.  
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24  
25 Reducing the toll of tobacco in Greece is not an easy task. Decisions should include fostering  
26  
27 an antismoking-culture through well-planned national antismoking campaigns, raising the  
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29 cigarettes prices at an initial level no less than €4 a pack and ensuring compliance with the  
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31 anti-smoking law, especially on the current occasion, when City Police (the main mechanism  
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33 of control on the matter) was recently abolished as an institution. Controlling illicit trade is  
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35 crucial to maximize the effect of interventions.  
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39 As regards to the limitations of this study, it must be noted that addictions models were  
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41 unable to provide statistically significant information, possibly due to the inclusion of 2012  
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43 data in the time series. Possible future analysis of an even wider time series could provide  
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45 even more reliable results, as multicollinearity could be fully cured. Furthermore, the study  
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47 could be strengthened by employing statistical tests on more observations, regarding the  
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49 endogeneity of cigarette prices. Moreover, the current study is based on the most popular  
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51 price category in order to estimate the impact of prices changes on cigarette demand. It is  
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53 possible that a weighted average for all the brands sold in Greece could eliminate  
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55 unilateralism on prices data. Still, the anticipated but not fully documented switch of Greek  
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3 smokers from manufactured cigarettes to hand-rolled tobacco should be taken into account  
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5 in any future research. Yet, if the increase of contraband cigarettes in the Greek market  
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7 could be quantified, results would be more punctual. In addition, tobacco shows synergistic  
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9 effect with other substances, such as alcohol. Thus, it would be meaningful to investigate  
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11 the combined effect of tobacco and alcohol from an economic aspect. Finally, researchers  
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13 argue that the increased availability of nicotine substitutes will reduce demand for tobacco  
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15 products and increase the price sensitivity as well.[19] Under that scope, if research included  
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17 nicotine substitutes, accuracy would be improved.  
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10

11  
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13  
14 reported in the text. FT and KA reviewed the literature for relevant data and documentation.  
15  
16 FT and KA drafted the manuscript which was edited and critically revised by KA, AV and JK.  
17  
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19  
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21  
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23  
24

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26  
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29  
30 price and Gross Domestic Product. Moreover, dummy variables of the analysis are based on  
31  
32 the Greek National Plan against Cancer (<http://www.epaac.eu/national-cancer-plans>) and  
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34 the Greek legislation [Law 3730/2008, effective from 23/12/2008 onwards and Law  
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36 3868/2010, effective from 03/08/2010 onwards, both available at Government Gazettes  
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38 (<http://www.et.gr/>)]. Unfortunately, aggregate cigarette consumption and weighted average  
39  
40 price for the period 1994-2012 are official but remain unpublished by the Greek Ministry of  
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42 Finance. Therefore, they are available upon request from the lead author (Filippos Tarantilis,  
43  
44 [fil\\_t@hotmail.com](mailto:fil_t@hotmail.com)). Due to the Ministry's often changing policy in terms of providing  
45  
46 information to the public, we rejected the option to share data in Dryad data repository.  
47  
48 Finally, Greek population and Gross Domestic Product for the arementioned period derived  
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50 from the World Bank database (<http://data.worldbank.org/>). No additional data were used.  
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52 Thus no additional data are available.  
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**Estimates of price and income elasticity in Greece:**

**Greek debt crisis transforming cigarettes into a luxury good - an econometric approach**

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**Abstract**

**Objective:** During the past decades, smoking prevalence in Greece was estimated near or over 40%. Following a sharp fall in newest data on cigarette consumption, our objective is to

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6 assess smokers' sensitivity to cigarette price and consumer income changes as well as to  
7 project health benefits of an additional tax increase.  
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10 **Methods:** Cigarette consumption was considered as the dependent variable, with Weighted  
11 Average Price as a proxy for cigarette price, GDP as a proxy for consumers' income and  
12 dummy variables reflecting smoking restrictions and antismoking campaigns. Values were  
13 computed to natural logarithms and regression was performed. Then, 4 scenarios of tax  
14 increase were distinguished in order to calculate potential health benefits.  
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21 **Results:** ~~Addiction models were unable to provide statistically significant information due to~~  
22 ~~a nearly 23.5% drop in consumption during 2012.~~ Short-run price elasticity is estimated at -  
23 0.441 and short-run income elasticity is estimated at 1.040. Antismoking campaigns were  
24 found to have a statistically significant impact on consumption. Results indicate that,  
25 depending on the level of tax increase, annual per capita consumption could fall by at least  
26 209.83 cigarettes; tax revenue could rise up by more than €0.74 billion, while smokers could  
27 be reduced by up to 530,568 and at least 465 smoking related deaths could be averted.  
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35 **Conclusions:** Price elasticity estimates are similar to previous studies in Greece, while  
36 income elasticity estimates are far greater. With cigarettes regarded as a luxury good, a  
37 great opportunity is presented for decision-makers to counter smoking. Increased taxation,  
38 along with focused antismoking campaigns, law reinforcement (to ensure compliance with  
39 smoking bans) and intensive control for smuggling could invoke a massive blow to the  
40 tobacco epidemic in Greece.  
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47 **Article Summary Strengths and limitations of this study**

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- The article offers information to policy makers regarding price elasticity, a key measure to perform tobacco control policy

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- The article reports, for the first time, an income elasticity above 1, as evidence that cigarettes tend to be considered a luxury good in Greece
- The analysis treats qualitative variables and projects health and financial benefits under extreme austerity
- The analysis could not include dynamic (addiction) models, as no statistical significance was reported

## Introduction

### Country Profile

Globally, more than 5 million people die every year from tobacco use, while tobacco use is the second leading cause of death, representing the 8.7% of global annual mortality .[1] As global tobacco consumption in 2009 was estimated at 5884 billion cigarettes,[2] tobacco clearly reflects the global transition from traditional risks such as undernutrition, unsafe sex, unsafe water, poor sanitation and hygiene to modern risks like physical inactivity, behavior risks and air quality.[1] In Greece, WHO estimations attribute 17% of mortality for people aged 30 or more to smoking.[3] Death rate attributed to tobacco and the proportion of deaths attributable to tobacco for ages 30 and over is documented in the following table (Table 1).

Table 1: Estimated death rated (per 100.000) and proportion attributable to tobacco for ages 30 and over, 2004 in Greece [3]

Cause of death	Death rate attributed to tobacco	Proportion of deaths attributable to tobacco
Lower respiratory infections	3	23%
Malignant neoplasms	110	29%
Cardiovascular diseases	90	12%
Respiratory diseases	23	37%

Little less than half Greek citizens (41%) are smokers.[4] Youth smoking is also high, 11.3% for young men and 9% for young women.[2] Environmental Tobacco Smoke (ETS) also represents a serious problem in Greece, as documented by previous research.[5]

Concerning cigarette affordability, findings suggest that Greece is one of the few high-income European Union countries with relatively low cigarette prices.[6] Low prices can be recognized as a factor for the tobacco epidemic in Greece.[7] According to own calculations,



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6 for the period 1992-2012, cigarette affordability, defined as the percentage of income  
7 needed to purchase 100 packs of cigarettes, was estimated from 0.56% to 1.98%.

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10 The first organized efforts to counter smoking in Greece were observed during 1979-1982.  
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12 At the moment, in Greece, tobacco advertising bans are complete, except for point-of-sale  
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14 advertising.

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17 Tax revenue from tobacco products is arguably very important for the economic policy. In  
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19 1990, tax revenue accounted for 4.4% of GDP.[8] For the period 1998-2010 tobacco tax  
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21 revenue stood for an annual average 2% of GDP, but it seems to follow a downwards trend.

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24 Official estimates measure the total annual direct cost of smoking a €2.14 billion, in an  
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26 environment where debt crisis and austerity measures set serious constraints to the health  
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28 system and resources should, now more than ever, be allocated properly. [9] Tobacco's  
29  
30 unfavorable consequences on the poor could become a factor, where unemployment rates  
31  
32 are estimated at 27.1% for the 2<sup>nd</sup> quarter of 2013, continuing to grow from under 900,000  
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34 to approximately 1,350,000 people in the last 24 months.[10] Moreover, 31% of the total  
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36 population is at risk of poverty or social exclusion.[11]

### 37 38 Tobacco Market and government interventions

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40 Three market failures differentiate an individual's choice to smoke compared to the decision  
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42 to consume other goods: information failure on the health hazard of smoking, information  
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44 failure on the addiction caused by smoking and external burden to non-smokers.[12]

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46 Therefore, government intervention is justified in order both to protect smokers from the  
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48 perilous habit and correct for externalities associated to smoking. From a basic economics'  
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50 standpoint, it can be claimed that smoking's immense social burden overtakes the loss of  
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52 consumer's utility or else the loss of economic efficiency (deadweight loss). -A hypothetical  
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6 example on how the deadweight loss emerges, after the introduction of tax, is illustrated in  
7 figures (Figure 1 and Figure 2).  
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10 Tobacco taxation is imposed through a variety of structures but, in nearly all cases, includes  
11 two main types of tax: Ad valorem tax, which represents a percentage of price and specific  
12 tax, which is a fixed tax per cigarette. In Greece, following the 2010 restructure of tobacco  
13 tax, total tax represents 86% of the retail price, significantly increased compared to the 2009  
14 level and 2008 level when is represented 83% and 70% of the retail price respectively (WHO,  
15 2011). In 2012, specific excise tax was regulated at €80 per 1,000 cigarettes and ad valorem  
16 tax at 20% of the retail price. Their minimum sum is required to be no less than €115 per  
17 1,000 cigarettes. Meanwhile, a specific excise tax was set at €153 per kg of hand-rolled  
18 tobacco. Sales tax for cigarettes is fixed at 23% of the retail price.  
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28 Price increases should not be regarded the only way to reduce consumption, as the impact  
29 of income, advertising and health education are also important.[13] Manipulating these  
30 variables will result to reduced consumption and eventually reduced mortality and  
31 morbidity. Tobacco control programs and policies are found to be either cost-saving or cost-  
32 effective, compared to other public health interventions such as cardiovascular risk  
33 counseling and cancer screening.[14] Research on the impact of tobacco control showed  
34 that during 1981-2000, increases in tobacco control program expenditures in the U.S.A. lead  
35 to reduced cigarettes sales. Authors also suggest that expenditures have an even stronger  
36 lagged influence on sales.[15] Smoking bans are adopted in order to limit exposure to smoke  
37 but also cause a remarkable decrease in cigarette consumption, as smokers' opportunities to  
38 smoke are lessened.[16] In Greece, the effort to restrict smoking in public places through  
39 legislation has failed due to low compliance with law.[17] Youth exposed to secondhand  
40 smoke at home are estimated at 89.8% of total youth population.[2] Public education  
41 campaigns, if "hard-hitting, sophisticated and sustained", can be extremely effective.[18]  
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### Price and income elasticities

The term used to measure the impact of a change in price on consumption is price elasticity of demand, defined as the percentage change in consumption that results from 1 percent increase in price.[19] Similarly, the impact of a change in income on consumption is measured by income elasticity, defined as the percentage change in consumption resulting from 1 percent increase in income. Estimating elasticity is crucial to policy makers in order not only to anticipate an intervention's impact both on tobacco consumption and tobacco tax revenue. If the proportionate fall in tobacco consumption exceeds the proportionate increase of tax, revenue will fall. Otherwise, revenue will rise.[16]

Results from a meta-analysis,[20] indicate that short run elasticity (-0.40) is lower than long run elasticity (-0.44), while in studies that included smuggling demand was less sensitive (-0.36). These findings confirm the general notion that a 10% increase in price would lead to a 4% reduction in consumption in high-income countries.[18] Stavrinou estimated the short run price elasticity at -0.079 and the long run at -0.147, while income elasticity is estimated at 0.18 and 0.33, respectively.[21] Hondroyannis and Papapetrou, based on data over the period 1967-1990, calculated the short run price elasticity at -0.33 and the long run at -0.6, while income elasticity estimations are 0.35 and 0.54, respectively. The fact that demand is inelastic is explained by the authors through addiction and the absence of direct substitutes. Furthermore, it is claimed that health warnings are more effective in reducing consumption than price increases.[9] Raptou and colleagues conclude in an income elasticity of 0.28, consisting of initiation elasticity (0.21) and consumption elasticity (0.07), arguing that income is a more important determinant for initiation rather than consumption. Furthermore, smoking bans are illustrated as a factor discouraging tobacco consumption.[22] Nikolaou and Velentzas, based on data from 1960 to 1995, estimated the short run price elasticity at -0.24 and the long run at -0.48, while income elasticity is

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6 estimated at 0.19 and 0.40, respectively. Advertising had a positive but non-significant effect  
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8 on demand and antismoking campaigns had a negative but non-significant effect on  
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10 demand.[23] On the other hand, health warnings on packs during 1987-1990 had a  
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12 significant negative impact on demand, lowering consumption by 4.2%. Dritsakis notes that  
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14 consumption is a negative function of price and health education expenditure and a positive  
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16 function of income as well.[24]

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18 As illustrated, there are no studies of price elasticity available for at least a decade. In the  
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20 light of the above, the purpose of the present study was to investigate cigarette demand in  
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22 Greece.

### 23 24 **Method**

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26 The tobacco product used in analysis is cigarettes, widely accepted as the major tobacco  
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28 product. In order to account for population growth, annual consumption per person over 15  
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30 was preferred to aggregate annual consumption. The threshold age was set at 15, as youth  
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32 smoking in Greece is considered substantial. Data on annual cigarette consumption are  
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34 available from 1994 onwards [\(1994-2012\) from the Greek Ministry of Finance](#).

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37 ~~Monthly (and quarterly) data on the quantities of taxed cigarettes were available from 2007~~  
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39 ~~to 2011.~~ As excise tax data were not available and MPPC (Most Popular Price Category)  
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41 shows inconsistency due to pricing policy, the measure chosen to reflect price was the  
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43 Weighted Average Price. Each pack consists of 20 cigarettes. The proxy used to deflate  
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45 nominal into real prices was calculated by comparing real and nominal values of GDP (Gross  
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47 Domestic Product) derived from World Bank. CPI (Consumer Price Index) was not selected as  
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49 a proxy due to a change in calculations by Hellenic Statistical Authority in 1995, when  
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51 General Harmonized Consumer Price Index was introduced. The base year set was 2005.  
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53 Disposable income data were based at GDP. Again, the threshold age was set at 15.  
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Deflation was not needed in that case, as real values were available. The base year set was 2005. Prior to 2008, national informative campaigns were not run in Greece at a national level. We considered The National Action Plan for Cancer (2008) as an anti-smoking campaign. A dummy variable was used to measure its influence on consumption. Expenditure on tobacco control was not available. Regulation for smoking bans and restrictions was only introduced in 2002 and amended in 2010. In order to measure its influence on consumption, an adjusted version of a previous reliable index was constructed, accounting not only for intensity of smoking restrictions but for compliance as well.[25] Values attributed were between 0 (no restrictions) to 1 (total ban) escalating by 0.25.

~~Regression analysis includes only a static model, as dynamic models (incorporating models) show limited statistical significance, due to the inclusion of 2012 data in the time series.~~

~~Data were analyzed with the statistical software packages SPSS® 20 and STATA® 9. The functional form used in the analysis was Double-log and values were transformed to natural logarithms in order to increase reliability. Testing for endogeneity of cigarette prices was not possible as the annual tax rates were only available from 2008 onwards. Time trend was found to be insignificant; therefore, it is excluded from the equations. The models of demand was were specified as follows.~~

*Conventional Demand Model*

$$\ln Q_t = b_0 + b_1 \ln P_t + b_2 \ln Y_t + b_3 SR_t + b_4 ASC_t + \varepsilon_t$$

*Myopic Addiction Model*

$$\ln Q_t = b_0 + b_1 \ln P_t + b_2 \ln Y_t + b_3 SR_t + b_4 ASC_t + b_5 \ln Q_{t-1} + \varepsilon_t$$

*Rational Addiction Model*

$$\ln Q_t = b_0 + b_1 \ln P_t + b_2 \ln Y_t + b_3 SR_t + b_4 ASC_t + b_5 \ln Q_{t-1} + b_6 \ln Q_{t+1} + \varepsilon_t$$

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$Q_t$  : consumption of cigarettes per person over 15 (000 cigarettes) in year t

$Q_{t-1}$  : consumption of cigarettes per person over 15(000 cigarettes) in year t-1

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$Q_{t+1}$  : consumption of cigarettes per person over 15(000 cigarettes) in year t+1

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$P_t$  : real retail price per pack of 20 cigarettes in year t

$Y_t$  : real per person over 15 disposable income (€000-€) in year t

$b_0$  : intercept in year t

$SR_t$  : index of smoking restrictions or bans according to law in year t

$AsC_t$  : dummy checking dichotomous index reflecting the existence of an anti-smoking campaign each year t

$\varepsilon_t$  : the error term

## Results

Through the conventional model of demand, the demand equation was estimated as follows

(Table 2):

Table 2: Conventional model of demand equation

$\ln Q_t = -1.757 - 0.441 \cdot \ln P_t + 1.040 \cdot \ln Y_t - 0.132 \cdot \text{AsC}_t$		
F-statistic: 27.765	R square: 0.847	Durbin-Watson: 1.980
Skewness/Kurtosis tests for Normality: $\text{adj chi}^2 = 5.10$ , $\text{Prob} > \text{chi}^2 = 0.0780$		
Breusch-Pagan / Cook-Weisberg test for heteroskedasticity: $\text{chi}^2 = 2.56$ , $\text{Prob} > \text{chi}^2 = 0.1093$		
Dickey-Fuller test for unit root: $Z(t) = -2.364$ , 1% critical value = -2.660, 5% critical value = -1.950, 10% critical value = -1.600		

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A regression analysis was performed and calculations were made stepwise. The variable created to capture the effect of smoking restrictions was found non-significant (p value asymptotically equal to 0.303 at 5% confidence level); thus, it is excluded from the model. P value at 5% confidence level is asymptotically equal to 0 for  $\ln Y_t$ , equal to 0.001 for  $\ln P_t$  and equal to 0.021 for  $\text{AsC}_t$ . The F-statistic is high, showing a good level of fit, while the model explains a great part of the variation. The Durbin-Watson statistic is close to 2, suggesting that the model has no autocorrelation. The Variation Inflated Factor is low for all variables, implying that multicollinearity is a non-factor. As evidenced by normality tests, standardized residuals follow a normal distribution. Breusch-Pagan / Cook-Weisberg tests indicate that residuals are homoscedastic. The Augmented Dickey-Fuller test for standardized residuals confirms that there exist no unit roots. Therefore, the standardized residuals are stationary, so the variables of the model are cointegrated (without constant and trend) and the

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6 regression is not spurious. In the light of the above, we accept a short-run price elasticity of  
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8 demand at 0.441 and a short-run income elasticity of demand at 1.040.

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11 Through the myopic addiction model, the additional variable ( $\ln Q_{t-1}$ ) shows no statistical  
12 significance. Therefore the model remains unchanged. Through the rational addiction  
13 model, only the variable representing following year's consumption ( $\ln Q_{t+1}$ ) is found  
14 significant (p value asymptotically equal to 0), with substantially lower levels of fit (R  
15 square). Thus, we conclude that addiction models fail to offer additional information on how  
16 consumption is influenced.

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20 Based on 2010 data, nominal tax revenue per pack is calculated at €2.78, a value verifying  
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22 and corresponding to the fixed amount of tax (86% of the nominal retail price). We assume  
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24 that the state maintains the existing ability to collect tribute. Government proclamations  
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26 suggest that tobacco will be further taxed. Therefore, we distinct four scenarios, all with  
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28 retail price increases, as anticipated, and each suggesting an additional price increase by  
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30 €0.5. Calculations are made only for the following year and accordingly only short run  
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32 elasticity is taken into account. Scenarios capture the impact of the continuing fall in income  
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34 at a rate of 4.8%. Based on Ross et al methodology and data concerning tobacco-related  
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36 mortality in Greece (Lower respiratory infections, Malignant neoplasms, Cardiovascular  
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38 diseases and Respiratory diseases), we estimate reduction on smokers and mortality  
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40 averted.[3,26]

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42 In all four scenarios, consumption is decreased substantially while tax revenue is still  
43 increased thanks to the inelastic demand. Moreover, smokers are significantly reduced and  
44 smoking related deaths are accordingly limited (Table 3).  
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Table 32: Impact of price increase and income constraints on consumption, tax revenue, number of smokers and smoking related deaths

Model scenarios	Scenario 1	Scenario 2	Scenario 3	Scenario 4	
Price per pack	€4.47	€4.97	€5.47	€5.97	
Percent increase of price	12.59%	25.19%	37.78%	50.38%	
Fall in consumption due to price increase	-5.55%	-11.11%	-16.66%	-22.22%	
Fall in consumption due to income decrease	-4.99%	-4.99%	-4.99%	-4.99%	
Per capita consumption level	1,779.84	1,669.33	1,558.82	1,448.31	
Per capita consumption deterred	209.83	320.34	430.85	541.36	
Tax revenue per pack	€3.84	€4.27	€4.70	€5.13	
Tax revenue per cigarette	€0.192	€0.214	€0.235	€0.257	
Total tax revenue (€ billion)	€3,336	€3,478	€3,575	€3,625	
Incremental tax revenue (€ billion)	€0,455	€0,597	€0,694	€0,744	
Reduction in number of smokers	205,650	313,956	422,262	530,568	
Smoking related deaths averted	high(0,50)	930	1,420	1,911	2,401
	low(0,25)	465	710	955	1,200

-Differences in calculations may occur due to rounding

-Impact of price increase shared between prevalence and consumption

-High estimate indicates that 50% of smokers' deaths are attributable to tobacco use, whereas low estimate indicates that 25% of smokers' deaths are attributable to tobacco use

~~In all four scenarios, consumption is decreased substantially while tax revenue is still increased thanks to the inelastic demand. Moreover, smokers are significantly reduced and smoking related deaths are accordingly limited.~~

## Discussion

Price elasticity estimates are greater than previous research in Greece,[8, 23-24] but consistent with findings by Gallet and List.[20] Estimates for income elasticity are far greater than estimates provided by literature in Greece.[8, 21-23] Regarding antismoking campaigns, results are in agreement with previous testimony.[23-24] Smoking restrictions show no statistical significance, confirming the claims by Joosens and Raw that compliance is low.[17] Finally, results are in general agreement with Alpert et al,[27] though a different methodology is followed.

Paired with the still high cigarette affordability, as documented in the current study and reported by previous research,[6] the nature of demand in Greece presents a vast opportunity for the policy makers to counter the tobacco epidemic and ensure revenue and cash flows at the same time. Even supposing that other determinants of demand, such as income, which is anticipated to fall, do not change, tobacco taxation proves to be a powerful tool. Annual consumption per person over 15 would be no higher than 1,780 cigarettes, even in the worst case (scenario1) and may fall to less than 1,448 cigarettes. On the other hand, tax revenue would recover from the downwards trend, accounting again for more than 1.80% of GDP, even in scenario1. In absolute values, excess tobacco tax revenue could rejuvenate the dismantled public coffers. Results suggest that even with a modest 10% of tax revenue allocated to offsetting the tobacco epidemic, there would be more than enough disposable funds towards planning, implementing, evaluating and improving antismoking efforts. Greeks seem to be in agreement with heavy taxation on cigarettes, but only if respective revenue is attributed to tobacco control.[28] In terms of public health benefits, smokers could be reduced by nearly 530,568 people, while up to 2,401 smoking related deaths could be averted on an annual basis. Nonetheless, findings should be treated with caution and increases in price should not be excessively increased from day one, as the

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6 smokers' reaction is not easy to predict with confidence intervals widened. A stepwise  
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8 increase of tax would eliminate many of the risks associated with a sharp and sudden  
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10 increase in cigarette prices. Besides, Greece already performs better in tax collection than  
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12 countries such as Germany, France and Slovenia among others,[26] as the excise per smoker  
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14 ratio indicates, with €738.71 collected for every smoker.

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16 Income sensitivity is larger than in any previous study either in Greece or internationally.  
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18 Thus, it is not exaggerating to argue that Greek smokers are shocked by the constraint on  
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20 their income. Besides, it is the first time in at least 40 years that income in Greece is falling at  
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22 this rate. The austerity measures should be viewed as a shift event in cigarette consumption,  
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24 among others.

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26 Reducing the toll of tobacco in Greece is not an easy task. Decisions should include fostering  
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28 an antismoking-culture through well-planned national antismoking campaigns, raising the  
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30 cigarettes prices at an initial level no less than €4 a pack and ensuring compliance with the  
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32 anti-smoking law, especially on the current occasion, when City Police (the main mechanism  
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34 of control on the matter) was recently abolished as an institution. Controlling illicit trade is  
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36 crucial to maximize the effect of interventions.

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39 As regards to the limitations of this study, it must be noted that addictions models were  
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41 unable to provide statistically significant information, possibly due to the inclusion of 2012  
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43 data in the time series. Possible future analysis of an even wider time series could provide  
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45 even more reliable results, as multicollinearity could be fully cured. Furthermore, the study  
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47 could be strengthened by employing statistical tests on more observations, regarding the  
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49 endogeneity of cigarette prices. Moreover, the current study is based on the most popular  
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51 price category in order to estimate the impact of prices changes on cigarette demand. It is  
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53 possible that a weighted average for all the brands sold in Greece could eliminate  
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55 unilateralism on prices data. Still, the anticipated but not fully documented switch of Greek  
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6 smokers from manufactured cigarettes to hand-rolled tobacco should be taken into account  
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8 in any future research. Yet, if the increase of contraband cigarettes in the Greek market  
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10 could be quantified, results would be more punctual. In addition, tobacco shows synergistic  
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12 effect with other substances, such as alcohol. Thus, it would be meaningful to investigate  
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14 the combined effect of tobacco and alcohol from an economic aspect. Finally, researchers  
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16 argue that the increased availability of nicotine substitutes will reduce demand for tobacco  
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18 products and increase the price sensitivity as well.[19] Under that scope, if research included  
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20 nicotine substitutes, accuracy would be improved.  
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6 **Contributorship Statement:** FT, [DZ](#) and AV performed the calculations and analyses  
7 reported in the text. FT and KA reviewed the literature for relevant data and documentation.  
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10 FT and KA drafted the manuscript which was edited and critically revised by KA, [AV](#) and IK.  
11

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**Figures**

Figure 1: The demand curve before government intervention

Figure 2: The demand curve after government intervention

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