RESEARCH PAPER

Price and cigarette consumption in Europe

S Gallus, A Schiaffino, C La Vecchia, J Townsend, E Fernandez

Tobacco Control 2006;**15**:114–119. doi: 10.1136/tc.2005.012468

See end of article for authors' affiliations

Correspondence to: Esteve Fernandez, MD, PhD, Cancer Prevention and Control Unit, Institut Català d'Oncologia, Av. Gran Via s/n, Km 2.7, 08907 L'Hospitalet, Spain; efernandez@iconcologia.net

Received 11 November 2005
Accepted 21 December 2005

Objective: To analyse the variation in demand for tobacco according to price of cigarettes across the European region.
Design: Cross-sectional study.
Setting: All the 52 countries of the European region.
Participants: For each European country, data were collected on annual per adult cigarette consumption (2000), smoking prevalence (most recent), retail price of a pack of local and foreign brand cigarettes (around 2000), the gross domestic product adjusted by purchasing power parities, and the adult population (2000).
Main outcome measure: Price elasticity of demand for cigarettes (that is, the change in cigarette consumption according to a change in tobacco price) across all the European countries, estimated by double-log multiple linear regression.
Results: Controlling for male to female prevalence ratio, price elasticities for consumption were −0.46 (95% confidence interval (CI) −0.74 to −0.17) and −0.74 (95% CI −1.13 to −0.35) for local and foreign brand, respectively. The inverse relation between cigarette price and consumption was stronger in countries not in the European Union (price elasticity for foreign brand cigarettes of −0.8) as compared to European Union countries (price elasticity of −0.4).
Conclusions: The result that, on average, in Europe smoking consumption decreases 5–7% for a 10% increase in the real price of cigarettes strongly supports an inverse association between price and cigarette smoking.

Economic aspects are one of the most important prevention strategies for smoking cessation and against smoking initiation and consumption.[1–4] The potential impact of tax increases on demand for cigarettes worldwide has been modelled in a report for the World Bank.[5] The model revealed that even modest price increases could have a striking impact on the prevalence of smoking and hence on the number of tobacco related premature deaths. It was estimated that a 10% increase over the average estimated price in each region could lead to 40 million people worldwide quitting smoking, and many more who would otherwise have taken up smoking would be deterred from doing so.[5] The assumptions on which the model was based, concerning price elasticity (that is, the percentage change in cigarette consumption for a 1% change in cigarette price), health impact, and other variables were highly conservative, and consequently the results were likely to underestimate the actual impact.

Many studies showed that price elasticity of demand had an appreciable impact on smoking consumption in several developed countries, including the UK (−0.36[6 7]), Finland (−0.49 to −0.94[8]), Italy (−0.43[9]), Spain (−0.19 to −1.25[10]), California (around −0.5,[11–13] −1.0 among Latino population[14]), the US District of Columbia (−0.48 to −0.62[15]), Canada (−0.5[16]), and Australia (−0.3 to −0.8[17]). A meta-analysis reviewing 86 different studies on economic aspects of smoking reported a mean price elasticity of −0.48.[2]

However, some aspects of the issue are still not fully elucidated. Recent data suggest that in poorer countries rising prices may not sensibly reduce smoking. In fact, although in some developing countries price elasticities were similar to those of developed countries (−0.71 in Papua New Guinea,[18] and −0.54 in China[19]), or even stronger,[1 5] a study conducted in Russia and China, and based on longitudinal micro-level household and community surveys, found estimates ranging from 0 to −0.15.[20]

Although price elasticity is usually estimated for individual countries with time series data, this can also be estimated from cross-sectional data at one period of time from different countries, assuming there are similar responses to price changes between them. An early study in the 1980s based on cross-sectional data from 27 European countries showed a price elasticity of −0.4 and an income elasticity of demand of 0.5.[7 21] This would mean that cigarette consumption will rise with incomes unless there are counter policies. Thus, to investigate the issue further, we performed a cross-sectional analyses including all the countries of the European continent. Europe has only 15% of the world population, but faces nearly one third of the worldwide burden of tobacco-related diseases.[22] It represents the ideal region to study such an issue for several reasons, including the high proportion of smokers, the availability of data, and the wide differences in terms of cigarette consumption among various countries. Moreover, despite attempts to harmonise tobacco tax rates within the European Union, there are still wide differences in prices.

MATERIALS AND METHODS

Data collection

The main sources of information were derived from the second edition of the *Tobacco Control Country Profiles* (TCCP)[23] published jointly by the American Cancer Society, the World Health Organization (WHO), and the International Union Against Cancer (UICC). The TCCP is a monograph on global tobacco control, collecting data for almost all the world nations from several sources. For each country, TCCP includes information on the sociodemographic situation, the most recent smoking prevalence, tobacco economics,

Abbreviations: GDP, gross domestic product; PPP, purchasing power parities; TCCP, *Tobacco Control Country Profiles*; UICC, International Union Against Cancer; WHO, World Health Organization

smoking-attributed and smoking-related disease impact, and infrastructure for tobacco control. From the TCCP we collected data for each European country on the following items: the population aged ⩾ 15 years in the year 2000, by sex; the annual per adult cigarette consumption in 2000, estimated by data from official legal trades as difference between production plus imports and exports in grams, divided by the adult population (1 cigarette stick was considered as 1 g in weight); the smoking prevalence, by sex, as the proportion (%) of the adult population who were current smokers of any type of tobacco product; the retail price of a pack of 20 cigarettes with taxes (US$) for the most popular foreign and domestic brand; the gross domestic product (GDP) of each country in 2000 (US$), adjusted for purchasing power parities (PPP), here abbreviated as GDP-PPP. We therefore derived the GDP-PPP-adjusted price, dividing price by GDP-PPP and multiplying the result by 14 000 US$ (the mean value among all the European countries). In order to minimise errors, we compared collected information with data from the World Bank.[24] We redirect readers to the Methods section of the TCCP for details on sources of data.

Countries included in the study

For the present analysis, we considered all the countries pertaining to the European region according to WHO classification, including therefore Israel, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan and Uzbekistan. Since recently Cyprus joined the European Union, we collected information on this nation, too, although classified by WHO as a country included in the Eastern Mediterranean region. Lack of information on cigarette consumption did not allow, however, Cyprus to be included in the final analyses. Liechtenstein and Vatican City were not included in the TCCP. Countries with no available data either on price of cigarettes, or on annual per capita consumption, were not considered in the final analyses. Thus, the number of countries in the analysis varied (see footnotes to tables). Countries were subsequently grouped as those pertaining or not to the European Union and by high and low GDP-PPP (cut-off at 15 000 US$).

Strategy of analysis and statistical methods

We fitted multiple linear regression models to explain the annual cigarette consumption per adult in terms of the GDP-PPP adjusted price of 20 cigarettes (in US$, taxes included) and male to female smoking prevalence ratio, taken as a proxy of the variable development of the smoking epidemic in each country.[23 25] The analyses were computed considering the real price of both the most popular foreign and domestic brands. According to previous research,[2 6] the following double-log functional form was used in the models (the log function is used to convert the data numbers into percentage figures, by which elasticities are evaluated), since price is likely to have a proportional effect on cigarette consumption:

$$\ln \mathrm{CigCons}_i = \alpha + \beta_1 \ln \mathrm{Price}_i + \beta_2 \ln \mathrm{M/FPR}_i + \epsilon_i$$

where $\mathrm{CigCons}_i$ is the annual cigarette consumption per adult for country i, Price_i in US$ is the GDP-PPP adjusted price of 20 cigarettes in country i, $\mathrm{M/FPR}_i$ is the male to female smoking prevalence ratio, and ϵ_i is a random error term. From this model, α is a constant, β_1 represents the price elasticity (the percent change in cigarette consumption according to the percent change in price), β_2 the effect on per adult consumption of male to female smoking prevalence ratio, and ϵ_i is the effect of random variation. In order to quantify the crude relation between the independent and the dependent variable, and to quantify the modifier effect of the adjustment term, we considered also a model including, among the independent variables, the price only. The coefficients' statistical significance was evaluated using the Wald test, and the goodness of fit was assessed by adjusted R^2. All the models were tested for the applicability conditions of linear regression (model specification, normality of errors, homoscedasticity, absence of multicollinearity, absence of outliers and lack of self-correlation).

RESULTS

We collected data on 52 countries of the European region. Table 1 shows for each European country the annual per adult consumption (in number of cigarettes), the smoking prevalence in the adult population in both sexes, the adult population (⩾ 15 years) in 2000, the price in US$ of a pack of foreign and domestic cigarettes, and the GDP-PPP in 2000.

Figure 1 shows the distribution of GDP-PPP adjusted price of a pack of cigarettes (panel A local, panel B foreign brand), according to the inclusion in the European Union, and the annual per adult cigarette consumption, for all the European countries with available information.

Table 2 shows the results of the linear regression models, considering annual per adult consumption fitted in order to estimate the price elasticity of demand for smoking across the European countries whose information was available (see footnotes to table 2). Considering the simpler model, including only price as independent variable, price elasticities of demand for cigarettes were −0.40 (95% confidence interval (CI) −0.68 to −0.12) for local and −0.85 (95% CI −1.17 to −0.53) for foreign brand. Controlling for male to female smoking prevalence ratio, the estimates were −0.46 (95% CI −0.74 to −0.17) and −0.74 (95% CI −1.13 to −0.35) for local and foreign brand, respectively. The multiple model fitted well the data for both the considered cigarette brands, but for local brand the multiple model explains a low percentage of the variability of cigarette consumption across countries (27%). Since levels of GDP-PPP may differ across European countries, we further fitted a model with non-GDP-PPP adjusted prices controlling for ln(GDP-PPP). The estimates did not differ, the price elasticity being −0.49 and −0.77 for local and foreign brand, respectively. For both local and foreign cigarette brands, we checked the final model in terms of error specification, normality, homoscedasticity, multicollinearity, outliers and self-correlation and all of the diagnostics showed that the chosen model fulfilled the assumptions. The male to female smoking prevalence ratio was inversely related to consumption, reflecting a higher total consumption where smoking is widespread in both sexes.

Table 3 shows the foreign brand price elasticity of demand for cigarettes separately for European Union and other countries, and according to GDP-PPP (see footnotes of table 3 for the list of countries included in the analyses). Considering the multiple model, the price elasticity was −0.43 (95% CI −1.07 to 0.21) across the countries pertaining to the European Union, and −0.87 (95% CI −1.67 to −0.07) across the countries not integrated in the European Union. The price elasticities were −0.76 (95% CI −1.34 to −0.19) and −0.41 (95% CI −1.23 to 0.41) across richer (GDP-PPP ⩾ 15 000 US$) and poorer (GDP-PPP < 15 000 US$) countries, respectively.

DISCUSSION

The results from this analysis support the inverse association between price and cigarette smoking in Europe. This study shows that on average across the European countries smoking consumption decreases by 7.4% (and by 4.6%) for a 10.0% increase in the price of foreign (and local) brand cigarettes. This is consistent with previous studies analysing time series data from individual countries worldwide,[2 6–19]

Table 1 Cigarette consumption, smoking prevalence, adult population, gross domestic product-purchasing power parities (GDP-PPP), and price of cigarettes of all the countries of the European region (data from TCCP[23])

Country	ISO	Annual per adult consumption (No. cigs)	Smoking prevalence (%)				Population (≥15 years), 2000 (millions)	Real price of a pack of cigarettes (US$)		GDP-PPP, 2000 ($)
			Men	Women	Age range (years)	Period		Domestic	Foreign	
Albania	AL	1056	60.0	18.0	≥15	1999/2000	2195	0.42§	–	3474
Andorra	AD	–	44.0	28.0	≥15	1997	86*	–	–	20984
Armenia	AM	–	67.5	3.1	Men 15–54; women 15–49	2000/2001	2889	–	0.90	2407
Austria	AT	1516	–	–	≥15	2000	6737	3.32	3.61	25133
Azerbaijan	AZ	573	30.2	1.1	≥16	2000	5711	0.71	1.02	2732
Belarus	BY	2000	53.0	9.0	≥18	2000	8283	–	–	7083
Belgium	BE	1837	28.0	20.0	≥15	2001	8478	2.92	3.17	25877
Bosnia-Herzegovina	BA	1456	–	–	≥15	1995	3224	0.84¶	0.84¶	5647
Bulgaria	BG	3407	38.4	16.7	≥18	1997	6697	0.27§	–	5698
Croatia	HR	1995	34.1	26.6	18–65	2000	3814	1.48	2.29	7104
Cyprus	CY	–	38.5	7.6	Adult: not specified	1998	603	1.34§	–	16135
Czech Rep	CZ	1800	36.2	22.0	15–64	2000	8585	1.31	1.61	13333
Denmark	DK	1856	32.0	29.0	≥15	2000	4349	4.48	4.48	26541
Estonia	EE	2103†	44.0	20.0	16–64	2000	1147	0.88§	–	8516
Finland	FI	1123	27.0	20.0	25–64	2000	4239	3.66	3.96	23588
FYR of Macedonia	MK	2310	–	–	≥15	.	1574	0.61§	–	4701
France	FR	1594	33.0	21.0	≥18	2000	48140	3.07	3.61	23353
Georgia	GE	–	60.0	15.0	40–65	1999	4185	0.19§	–	2814
Germany	DE	1843	38.9	30.6	18–59	2000	69278	3.05	3.15	24052
Greece	GR	2977	46.8	29.0	≥15	2000	9012	1.98	2.48	15557
Hungary	HU	2654	53.1	30.4	≥18	1999	8279	0.99	1.68	11676
Iceland	IS	1956	25.3	22.9	18–69	2000	214	5.04	5.04	28206
Ireland	IR	2304	32.0	31.0	Adult: not specified	1998	2983	5.11	5.15	25054
Israel	IL	2250†	38.6	22.1	25–64	1999–2001	4334	2.53	3.59	18898
Italy	IT	2039	31.1	22.3	≥15	2002	49314	2.16	3.07	22619
Kazakhstan	KZ	1881	–	–	Adult: not specified	2000	11809	0.37§	–	5689
Kyrgyzstan	KG	–	60.0	15.6	18–65	1998	3251	–	–	2504
Latvia	LV	–	49.1	13.0	Adult: not specified	1999	2000	0.48§	–	6263
Lithuania	LT	1511	51.0	15.8	≥15	2000	2977	0.50§	–	6562
Luxembourg	LU	–	39.0	27.0	≥15	1998	355	2.18	2.57	39870
Malta	MT	2959‡	33.7	14.9	≥15	1995	311	2.33§	–	14353
Moldova	MD	–	46.0	18.0	Adult: not specified	1999	3302	0.19¶	–	2005
Monaco	MC	–	–	–		.	33	–	–	23753
Norway	NO	721	31.0	32.0	16–74	1999–2000	3586	8.37	8.37	28951
Poland	PL	2395	42.0	23.0	≥15	1997–1999	31210	1.13	1.51	8631
Portugal	PT	1998	29.4	6.4	≥19	1995–1996	1672	2.13	2.13	16225
Romania	RO	1730	61.7	25.0	25–45	1995	18343	0.58	0.73	6771
Russia	RU	2919	63.7	9.2	≥20	1992–1998	119368	0.57	1.01	5575
San Marino	SM	–	28.0	17.0	≥14	Early 1990	27	–	–	23812
Serbia and Montenegro	YU	1961	50.9	33.3	35–64	1994–1995	8439	22.00**	90.00**	3989
Slovakia	SK	1529	41.1	14.7	≥15	1998	4345	0.66	–	10702
Slovenia	SI	2658	28.0	20.1	25–65	2001	1672	0.93	1.45	16171
Spain	ES	2909	39.1	24.6	≥16	2001	34036	1.39	2.38	18087
Sweden	SE	1107	17.4	20.4	16–84	2000–2001	7234	4.02	4.13	23306
Switzerland	CH	2809	26.9	24.0	35–74	2000–2001	5976	3.27	3.27	27825
Tajikistan	TJ	–	–	–		.	3690	–	–	1015
Netherlands	NL	2951	32.2	25.3	≥15	2001	12962	3.17	3.17	24731
Turkey	TR	2159	50.9	10.9	≥20	1997–1998	46647	1.07	1.41	6194
Turkmenistan	TM	–	27.0	1.0	≥15	1990	2954	–	–	3411
Ukraine	UA	1242	56.9	10.0	≥18	2000	40728	0.26	0.71	3458
UK	GB	1374	28.0	26.0	≥16	2001	48142	6.93	6.93	22461
Uzbekistan	ZU	361	40.0	1.0	≥15	1991	9022	–	1.55	2329

Countries of the European Union are in bold.
*Total population; †annual per adult consumption (number of cigarettes) for 1995; ‡annual per adult consumption (number of cigarettes) for 1980; §price for the most popular price category; ¶average price; **prices not expressed in dollars but in local currency.
FYR, Former Yugoslav Republic; ISO, International Organization for Standardization country abbreviation.

and in broad agreement with an early cross sectional analyses of some European countries.[7 21]

The model used assumes constant price elasticity across different prices, but when comparing the price elasticity between countries according to GDP-PPP, we found a stronger effect on consumption in richer countries. This is consistent with the suggestion by Lance *et al*,[20] that in poorer countries the effect of price is smaller, but from this analysis in countries with a low GDP-PPP still an increase of 10% in prices would lead to a 4% decrease in consumption.

There are some limitations in our study. First of all, the lack of information, particularly in poorer countries, either on annual cigarette consumption, or on price of cigarettes, or on annual per capita consumption, or on smoking prevalence did not allow to consider all the European countries in the analyses.

Another potential weakness of our study was the impossibility to consider information on detailed tobacco control policies on a country level as well as on smuggling. Although therefore annual per adult cigarette consumption was derived

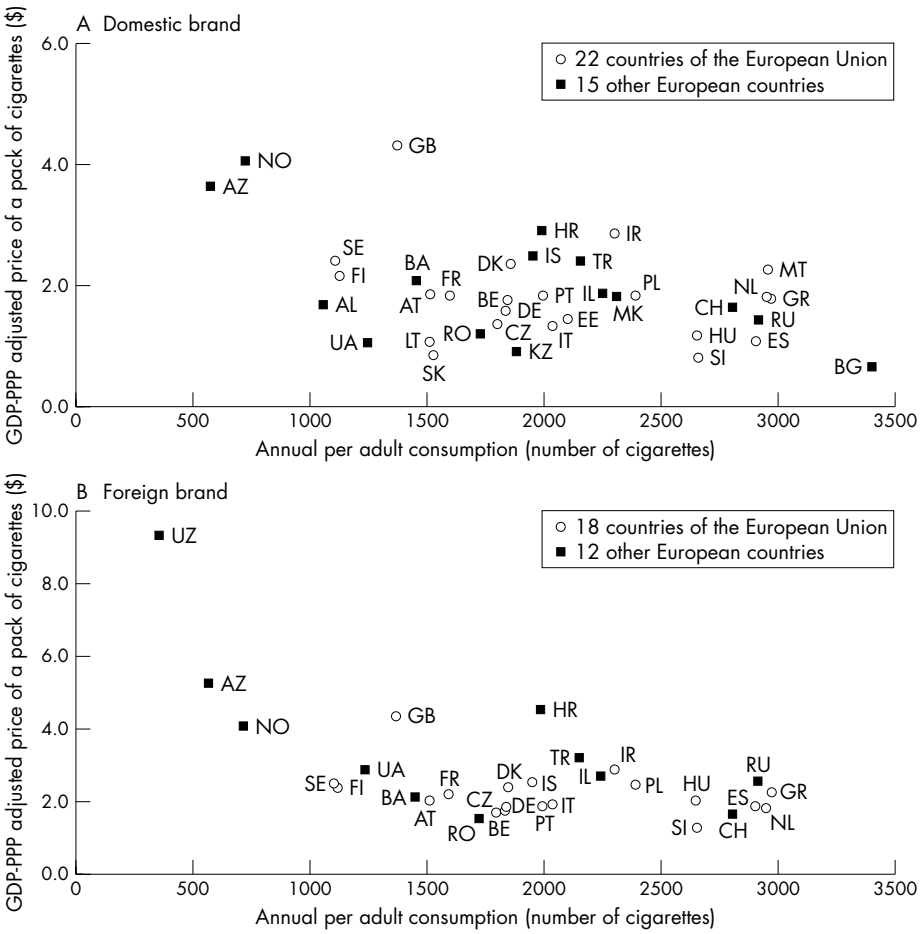

Figure 1 Distribution of gross domestic product-purchasing power parities (GDP-PPP) adjusted price of a pack of cigarettes and annual per adult cigarette consumption. (A) Domestic brand. (B) Foreign brand. See table 1 for abbreviations of countries (ISO).

from official tobacco sales, analyses on consumption could be biased by the heterogeneous proportion of smuggling on cigarette sales among European countries. Smuggling has been widespread over the last two decades in several countries, including Spain, Italy, Austria, Germany, Greece and most Eastern European countries, accounting for 10–40% of cigarette sales.[26] These were countries with relatively low taxes and low prices, but for reasons related to distribution networks and other factors facilitating smuggling, these countries were targeted by smugglers.[26–28] The large disagreement between the high smoking prevalence and the low estimate of cigarette consumption in Albania (table 1) gives a good example on how consumption can be influenced by smuggling. In fact, official data from the Albanian Ministry of Finance showed that approximately 40% of tobacco products were smuggled in Albania.[29] Moreover, the limited available data on smuggling are often unreliable, and the proportion of smuggling on cigarette sales can change rapidly. As an example, in Italy tobacco smuggling has been considered to cover 10–20% of the tobacco trades in 2000,[26] but a recent survey showed that in 2004 it decreased to less than 5%.[30] Similarly, in Spain, smuggling covered 30% of all

Table 2 Model of cigarette consumption across European countries

	Annual cigarette consumption			
	Local brand cigarettes*		Foreign brand cigarettes†	
Independent variables	Model 1 β (95% CI)	Model 2 β (95% CI)	Model 1 β (95% CI)	Model 2 β (95% CI)
Constant (α)	7.74 (7.55 to 7.93)	7.92 (7.67 to 8.16)	8.21 (7.90 to.53)	8.22 (7.88 to.55)
GDP-PPP adjusted price	−0.40 (−0.68 to −0.12)	−0.46 (−0.74 to −0.17)	−0.85 (−1.17 to −0.53)	−0.74 (−1.13 to −0.35)
Male to female smoking prevalence ratio		−0.19 (−0.38 to −0.01)		−0.11 (−0.28 to 7)
Adjusted R^2	0.17	0.27	0.49	0.53
Significance of model F (p value)	8.60 (0.006)	6.94 (0.003)	29.18 (<0.001)	16.03 (<0.001)

*List of countries: Albania, Azerbaijan, Belgium, Bulgaria, Croatia, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Lithuania, Malta, Norway, Poland, Portugal, Romania, Russia, Slovakia, Slovenia, Spain, Sweden, Switzerland, The Netherlands, Turkey, Ukraine, United Kingdom.
†List of countries: Azerbaijan, Belgium, Croatia, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Norway, Poland, Portugal, Romania, Russia, Slovenia, Spain, Sweden, Switzerland, The Netherlands, Turkey, Ukraine, United Kingdom, Uzbekistan.
GDP-PPP, gross domestic product-purchasing power parities.

Table 3 Model of cigarette consumption separately by countries of the European Union (EU) and other countries, and by high or low GDP-PPP, considering the most popular foreign brand cigarettes

	Annual cigarette consumption	
Independent variables	**Model 1 β (95% CI)**	**Model 2 β (95% CI)**
EU countries	(n = 18)	(n = 17)
Constant (α)	7.95 (7.49 to 8.40)	7.87 (7.28 to 8.45)
GDP-PPP-adjusted price	−0.49 (−1.07 to 0.09)	−0.43 (−1.07 to 0.21)
Male to female prevalence ratio		0.14 (−0.33 to 0.62)
Other countries	(n = 12)	(n = 11)
Constant (α)	8.38 (7.68 to 9.09)	8.42 (7.61 to 9.24)
GDP-PPP adjusted price	−1.00 (−1.57 to −0.42)	−0.87 (−1.67 to −0.07)
Male to female prevalence ratio		−0.12 (−0.44 to 0.20)
GDP-PPP ⩾ 15000US$	(n = 19)	(n = 18)
Constant (α)	8.16 (7.73 to 8.59)	8.12 (7.57 to 8.68)
GDP-PPP adjusted price	−0.79 (−1.30 to −0.28)	−0.76 (−1.34 to −0.19)
Male to female prevalence ratio		0.10 (−0.39 to 0.58)
GDP-PPP < 15000US$	(n = 11)	(n = 10)
Constant (α)	8.29 (7.56 to 9.01)	8.28 (7.60 to 8.97)
GDP-PPP adjusted price	−0.90 (−1.51 to −0.29)	−0.41 (−1.23 to 0.41)
Male to female prevalence ratio		−0.34 (−0.72 to 0.04)

*List of countries: Azerbaijan, Belgium, Croatia, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Norway, Poland, Portugal, Romania, Russia, Slovenia, Spain, Sweden, Switzerland, The Netherlands, Turkey, Ukraine, United Kingdom, Uzbekistan.
GDP-PPP, gross domestic product-purchasing power parities.

tobacco sales in 1993,[31] declined to 15% in 1995,[27] and to 5% in 1999.[10 28]

As an indicator of the different phases of the tobacco epidemic,[23 25] we chose the male to female smoking prevalence ratio in order to mitigate the biases given by the different choice of age groups included in various European surveys. According to the model by Lopez *et al*,[25] a higher male to female smoking prevalence ratio is an indicator of an early stage of the tobacco epidemic. In our data male to female smoking prevalence ratio was correlated both with annual per adult cigarette consumption (r = 0.48), with GDP-PPP (r = 0.46) and with smoking prevalence (r = −0.40). To test whether the male to female prevalence ratio was useful as an indicator of the stage of the epidemic, we added an interaction term with price to the model, which gave a coefficient of −0.009 (95% CI −0.023 to 0.005) for the domestic brand, and −0.003 (95% CI −0.007 to 0.0002) for the foreign brand. This indicates that the male to female prevalence ratio is an acceptable proxy for the stage of the epidemic in western and central Europe, although this may not apply to Russia and South-East Asia.[23]

For an addictive substance such as nicotine, the individual's current consumption levels will be determined by his or her past consumption levels as well as by the current price. This relation between past and current consumption has important implications for modelling the impact of price rises on demand for tobacco. The economic literature suggested that a real and permanent price increase corresponds to a decrease on demand approximately twice as large in the long run as compared to the short run.[17 32]

Some studies suggested that smokers of lower socioeconomic class were more responsive to changes in the price of cigarettes.[3 6 33–37] This gives further importance to the use of economic aspects as a strategy of intervention in several countries, including Italy,[38 39] Spain,[40 41] the Netherlands[42] and the UK,[43] in which, for both sexes, a progressive disadvantage in terms of smoking prevalence for the low-educated categories was found.[38 44]

Economic aspects also may deter smoking initiation, since younger generations tend to be more sensitive to cigarette prices.[2 36 45] The meta-analysis by Gallet and List[2] showed a price elasticity of −1.43 for teenagers, −0.76 for young adults, and −0.32 for adults. Another study showed that price elasticity highly influenced smoking prevalence in the youth (price elasticity −1.4), and relatively less in the adult population (price elasticity nearly −0.2).[37] Another study conducted on a cohort of 18 year old subjects from the United States showed how, through large-scale multimedia campaigns and a 1US$ increase in the price per pack of cigarettes, smoking prevalence could be reduced by 26% and would result in an annual saving of more than 100 000 lives and 1.6 million years of potential life lost.[46] Finally, analysing longitudinal data on young adults, Tauras[47] found a price elasticity for cessation of −0.35, suggesting that a significant increase in cigarette excise taxes may be one of the most effective means to reduce premature death and disease in the United States.[47] The issue of price and cessation in the young is, however, still open to discussion, since young adults are more frequently occasional smokers,[48] and could therefore be less influenced by prices.[13] This line of reasoning could be extended to women, and could explain, at least in part, the gender-specific differences found in the impact of price on smoking initiation and cessation, women being less sensitive to cigarette prices.[2 49]

In some European countries, including the United Kingdom, Spain and Italy, the average real price of cigarettes, standardised by GDP, is today appreciably lower (almost one

What this paper adds

Economic aspects are considered as one of the most important prevention strategies for smoking cessation and against smoking initiation and consumption. Price elasticities (that is, the percent change in cigarette consumption for a 1% change in cigarette price) are usually estimated for individual countries with time series data.

Estimating price elasticity for smoking from ecological cross-sectional data at one period of time from different European countries, smoking consumption decreases 5–7% for a 10% increase in the real price of cigarettes. The results from this analysis support the inverse association between price and cigarette smoking found in several studies from developed countries.

half) as compared to that of 30 years ago.[9 10 50] This suggests that a considerable increase of taxation is possible, socially acceptable and likely to be effective in several countries.[50 51] Increment of taxes could be allocated for tobacco control and prevention of tobacco-related diseases. As an example, nowadays in Italy, no revenue from tobacco products is spent for tobacco control,[9] as compared to a mean of about US$3.5 per capita in 2001 in the United States.[52 53] Last but not least, increasing taxes is the best strategy giving to governments a real profit, at least in the short run.[1 5]

Authors' affiliations

S Gallus, C La Vecchia, Istituto di Ricerche Farmacologiche ''Mario Negri'', Milan, Italy
A Schiaffino, E Fernandez, Cancer Prevention and Control Unit, Institut Català d'Oncologia, L'Hospitalet (Barcelona), Spain
C La Vecchia, Istituto di Statistica Medica e Biometria, Universita degli Studi di Milano, Milan, Italy
J Townsend, London School of Hygiene and Tropical Medicine, London University, London, UK
E Fernandez, Department of Experimental and Health Sciences, Universitat Pompeu Fabra, Barcelona, Spain

Funding: UICC International Cancer Technology Transfer Fellowship, Italian Association for Research on Cancer (AIRC), Italian Ministry of Health, Italian League Against Cancer, Spanish Ministry of Health (Research Networks on Cancer, RTICC C03/10, and Epidemiology and Public Health, RCESP C03/10), Catalan Ministry of Universities and Research (Thematic Network on Smoking Prevention, 2003XT/00090) and European Commission (Europe Against Cancer, European Network for Smoking Prevention, N° SI2.32443; 2001CVG2−008).

Competing interests: All authors declare that the answer to the questions on your competing interest form (http://bmj.com/cgi/content/full/317/7154/291/DC1) are all ''No'' and therefore have nothing to declare.

SG and EF had the original idea for the study and drafted the paper. SG and AS collected and analysed the data. AS, CLV and JT contributed to study design and revised the manuscript. EF is the guarantor.

REFERENCES

1 **Jha P**, Chaloupka FJ. The economics of global tobacco control. *BMJ* 2000;**321**:358–61.
2 **Gallet CA**, List JA. Cigarette demand: a meta-analysis of elasticities. *Health Econ* 2003;**12**:821–35.
3 **Liang L**, Chaloupka F, Nichter M, *et al*. Prices, policies and youth smoking, May 2001. *Addiction* 2003;**98**:105–22.
4 **Jamrozik K**. Population strategies to prevent smoking. *BMJ* 2004;**328**:759–62.
5 **Jha P**, Chaloupka FJ, eds. *Curbing the epidemic: governments and the economic aspects of tobacco control*. Washington, DC: The World Bank, 1999.
6 **Townsend J**, Roderick P, Cooper J. Cigarette smoking by socioeconomic group, sex, and age: effects of price, income, and health publicity. *BMJ* 1994;**309**:923–7.
7 **Townsend J**. Price and consumption of tobacco. *Br Med Bull* 1996;**52**:132–42.
8 **Pekurinen M**. The demand for tobacco products in Finland. *Br J Addict* 1989;**84**:1183–92.
9 **Gallus S**, Fernandez E, Townsend J, *et al*. Price and consumption of tobacco in Italy over the last three decades. *Eur J Cancer Prev* 2003;**12**:333–7.
10 **Fernandez E**, Gallus S, Schiaffino A, *et al*. Price and consumption of tabacco in Spain over the period 1965–2000. *Eur J Cancer Prev* 2004;**13**:207–11.
11 **Keeler TE**, Hu TW, Barnett PG, *et al*. Taxation, regulation, and addiction: a demand function for cigarettes based on time-series evidence. *J Health Econ* 1993;**12**:1–18.
12 **Hu TW**, Ren QF, Keeler TE, *et al*. The demand for cigarettes in California and behavioural risk factors. *Health Econ* 1995;**4**:7–14.
13 **Sheu ML**, Hu TW, Keeler TE, *et al*. The effect of a major cigarette price change on smoking behavior in California: a zero-inflated negative binomial model. *Health Econ* 2004;**13**:781–91.
14 **Emery S**, Ake CF, Navarro AM, *et al*. Simulated effect of tobacco tax variation on Latino health in California. *Am J Prev Med* 2001;**21**:278–83.
15 **Yurekli AA**, Zhang P. The impact of clean indoor-air laws and cigarette smuggling on demand for cigarettes: an empirical model. *Health Econ* 2000;**9**:159–70.
16 **Gruber J**, Sen A, Stabile M. Estimating price elasticities when there is smuggling: the sensitivity of smoking to price in Canada. *J Health Econ* 2003;**22**:821–42.
17 **Scollo M**, Younie S, Wakefield M, *et al*. Impact of tobacco tax reforms on tobacco prices and tobacco use in Australia. *Tob Control* 2003;**12**(suppl II):ii59–66.
18 **Chapman S**, Richardson J. Tobacco excise and declining tobacco consumption: the case of Papua New Guinea. *Am J Public Health* 1990;**80**:537–40.
19 **Hu TW**, Mao Z. Effects of cigarette tax on cigarette consumption and the Chinese economy. *Tob Control* 2002;**11**:105–8.
20 **Lance PM**, Akin JS, Dow WH, *et al*. Is cigarette smoking in poorer nations highly sensitive to price? Evidence from Russia and China. *J Health Econ* 2004;**23**:173–89.
21 **Townsend J**. *Price, tax and smoking in Europe*. Copenhagen, Denmark: World Health Organization, 1988.
22 **WHO European strategy for smoking cessation policy**. Revision 2004. Copenhagen, Denmark: World Health Organization, 2004, http://www.euro.who.int/Document/E80056.pdf (Accessed Jan 30, 2005).
23 **Shafey O**, Dolwick S, Guindon GE, eds. *Tobacco Control Country Profiles 2003*. Atlanta, Georgia: American Cancer Society, 2003.
24 **Guindon GE**, Boisclair D. *Past, current and future trends in tobacco use*. Washington DC, USA: The International Bank for Reconstruction and Development/The World Bank, 2003.
25 **Lopez AD**, Collishaw NE, Piha T. A descriptive model of the cigarette epidemic in developed countries. *Tob Control* 1994;**3**:242–7.
26 **Mackay J**, Eriksen M. *The tobacco atlas*. Geneva: World Health Organization, 2000.
27 **Joossens L**, Raw M. Cigarette smuggling in Europe: who really benefits? *Tob Control* 1998;**7**:66–71.
28 **Joosens L**, Raw M. How can cigarette smuggling be reduced? *BMJ* 2000;**321**:947–9.
29 **WHO Regional Office for Europe, Tobacco control database**. World Health Organization, 2003. http://data.euro.who.int/tobacco/.
30 **Gallus S**, Fernandez E, Pacifici R, *et al*. Channels of cigarette distribution, price and tobacco consumption in Italy. *Prev Med*, (in press).
31 **Gonzalez Garcia IM**. Medidas anti-fraude en Espana y logros alcanzados en el control del contrabando. In: Workshop on price, taxes, and smuggling in Spain: trends and relevance for health, Comité Nacional para la Prevencion del Tabaquismo, Madrid, Spain, 2000.http://www.globalink.org/tobacco/docs/eu-docs/0004maroto.shtml (Accessed Jan 30, 2005).
32 **Lopez-Nicolas A**. How important are tobacco prices in the propensity to start and quit smoking? An analysis of smoking histories from the Spanish National Health Survey. *Health Econ* 2002;**11**:521–35.
33 **Lewit EM**, Coate D. The potential for using excise taxes to reduce smoking. *J Health Economics* 1982;**1**:121–45.
34 **Chaloupka FJ**. Rational addictive behavior and cigarette smoking. *J Political Economy* 1991;**99**:722–42.
35 **Chaloupka FJ**, Pacula RL. Sex and race differences in young people's responsiveness to price and tobacco control policies. *Tob Control* 1999;**8**:373–7.
36 **Pinilla J**. Efecto de la experiencia en el hábito tabáquico sobre la percepción de la sensibilidad a los precios de los cigarillos en los jóvenes. *Gac Sanit* 2001;**15**(suppl 3):38.
37 **Ding A**. Youth are more sensitive to price changes in cigarettes than adults. *Yale J Biol Med* 2003;**76**:115–24.
38 **Faggiano F**, Versino E, Lemma P. Decennial trends of social differentials in smoking habits in Italy. *Cancer Causes Control* 2001;**12**:665–71.
39 **Federico B**, Kunst AE, Vannoni F, *et al*. Trends in educational inequalities in smoking in northern, mid and southern Italy, 1980–2000. *Prev Med* 2004;**39**:919–26.
40 **Fernandez E**, Garcia M, Schiaffino A, *et al*. Smoking initiation and cessation by gender and educational level in Catalonia, Spain. *Prev Med* 2001;**32**:218–23.
41 **Regidor E**, Gutierrez-Fisac JL, Calle ME, *et al*. Trends in cigarette smoking in Spain by social class. *Prev Med* 2001;**33**:241–8.
42 **Droomers M**, Schrijvers CT, Mackenbach JP. Educational differences in the intention to stop smoking: explanations based on the theory of planned behaviour. *Eur J Public Health* 2004;**14**:194–8.
43 **Dobson R**. Poor more likely to smoke and less likely to quit. *BMJ* 2004;**328**:914.
44 **Cavelaars AE**, Kunst AE, Geurts JJ, *et al*. Educational differences in smoking: international comparison. *BMJ* 2000;**320**:1102–7.
45 **Ross H**, Chaloupka FJ. The effect of cigarette prices on youth smoking. *Health Econ* 2003;**12**:217–30.
46 **Rivara FP**, Ebel BE, Garrison MM, *et al*. Prevention of smoking-related deaths in the United States. *Am J Prev Med* 2004;**27**:118–25.
47 **Tauras JA**. Public policy and smoking cessation among young adults in the United States. *Health Policy* 2004;**68**:321–32.
48 **Biener L**, Albers AB. Young adults: vulnerable new targets of tobacco marketing. *Am J Public Health* 2004;**94**:326–30.
49 **Cawley J**, Markowitz S, Tauras J. Lighting up and slimming down: the effects of body weight and cigarette prices on adolescent smoking initiation. *J Health Econ* 2004;**23**:293–311.
50 **Guindon GE**, Tobin S, Yach D. Trends and affordability of cigarette prices: ample room for tax increases and related health gains. *Tob Control* 2002;**11**:35–43.
51 **Gallus S**, Colombo P, Apolone G, *et al*. A tax to prevent the epidemic of lung cancer. *Lancet* 2005;**366**:288.
52 **Gross CP**, Soffer B, Bach PB, *et al*. State expenditures for tobacco-control programs and the tobacco settlement. *N Engl J Med* 2002;**347**:1080–6.
53 **Schroeder SA**. Conflicting dispatches from the tobacco wars. *N Engl J Med* 2002;**347**:1106–9.