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Demand for Tobacco in Europe

An Econometric Analysis of 11 Countries for the PPACTE Project

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Lien Nguyen, Gunnar Rosenqvist, Markku Pekurinen

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SEVENTH FRAMEWORK PROGRAMME

PPACTE
PRICING POLICIES AND CONTROL OF TOBACCO IN EUROPE

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Helsinki, November 28, 2011

Lien Nguyen *Gunnar Rosenqvist* *Markku Pekurinen*

Abstract

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Background. Pricing policy is seen as the most important intervention in tobacco control to reduce smoking. We analyzed the price elasticities and other key determinants of demand for tobacco in 11 European countries (Austria, Finland, France, Germany, Ireland, Italy, the Netherlands, Portugal, Spain, Sweden, and the United Kingdom) and evaluated to what extent demand for the selected tobacco products can be controlled by price and other policy measures.

Methods. The annual time series covered periods ranging from 30 to 60 years, ending in 2009. Cigarettes were consumed in all countries studied, whereas pipe and hand-rolling tobacco and snus were the second most used products in some of the countries. Per capita consumption of each of these products was explained in each country-specific analysis by the real price of tobacco products, real disposable income per capita, and a tobacco control policy index measuring the magnitude of implemented tobacco control policies at country level. Working from the theory of demand and addiction, we applied conventional, partial adjustment and rational addiction models. Taking into account time-series properties of variables, error correction models were also considered. Dynamic models were estimated by instrumental variable methods (2SLS) and the Engle-Granger two-step method.

Results. Results are based on the estimated models that fully or nearly passed the residual autocorrelation tests conducted. For cigarettes, the short-run price elasticities of demand obtained ranged from –0.30 to –0.40 (i.e., a 10% increase in real cigarette price will reduce cigarette consumption by 3–4%). For pipe and hand-rolling tobacco in Finland and for snus in Sweden, the short-run price elasticity estimates were –0.43 and –0.24. Pipe and hand-rolling tobacco appeared to be a substitute for cigarettes in Finland owing to the cross-price elasticity of demand 1.73 (i.e., a 10% increase in real cigarette price will boost consumption of pipe and hand-rolling tobacco by 17.3%). The long-run price elasticities of demand for cigarettes resulting from the most preferred models ranged from –0.21 to –1.49, with the typical value close to –1.0. The greater variability and smaller reliability of these long-run price elasticity estimates compared to short-run price elasticity estimates were due to technical reasons.

Higher real disposable income was associated with higher cigarette consumption. Most of the income elasticity estimates varied between 0.10 and 0.60, with the median being between 0.30 and 0.40, indicating that a 10% increase in real disposable income tends to increase cigarette consumption by 3–4%. Higher real household disposable income was associated with lower consumption of pipe and

hand-rolling tobacco in Finland and in the Netherlands. For most of the countries studied, the tobacco control policy index variable was negatively related to cigarette consumption: a 10-point increase in the tobacco control policy index 0–100 would reduce cigarette consumption by 2–3%.

Conclusions. Our results imply that price policy and other tobacco control policies are clearly effective in reducing the consumption of cigarettes. However, they also suggest that the planning of tobacco control policies should pay attention to methods so as to more effectively highlight the harmful health effects of tobacco products other than cigarettes. In addition, to better counteract the impact of increasing real disposable income on tobacco consumption, tobacco control policies need to take account of developments in real disposable income.

Keywords: demand for tobacco, consumption of tobacco, tobacco control policy, econometric analysis of demand, econometric models, elasticity, time series, addiction

Tiivistelmä

Lien Nguyen, Gunnar Rosenqvist, Markku Pekurinen. Demand for Tobacco in Europe. An Econometric Analysis of 11 Countries for the PPACTE Project [Ekonometrinen analyysi tupakkatuotteiden kysynnästä 11 Euroopan maassa]. Terveyden ja hyvinvoinnin laitos (THL). Raportti 6/2012. 172 sivua. Helsinki 2012.
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Tausta. Hintapolitiikkaa pidetään yhtenä tehokkaimpana keinona vähentää tupakan kulutusta. Tutkimme, mitkä tekijät vaikuttavat tupakkatuotteiden kysyntään ja miten erityisesti hintapolitiikalla voidaan säädellä kulutusta 11 EU-maassa (Alankomaat, Espanja, Irlanti, Iso-Britannia, Italia, Itävalta, Portugali, Ranska, Ruotsi, Saksa ja Suomi).

Menetelmät. Aineistoina käytettiin tupakkatuotteiden aggregoituja vuositason aikasarja-aineistoja, jotka kattoivat maasta riippuen 30–60 vuotta päättyen vuoteen 2009. Savukkeet olivat ylivoimaisesti suosituin tupakkalaji kaikissa tutkituissa maissa. Piippu- ja savuketupakkaa ja nuuskaa kulutettiin merkittävässä määrin muutamassa maassa. Kunkin tarkastellun tupakkatuotteen kulutusta 15 vuotta täyttänyttä kohti selitettiin tupakkatuotteiden reaalihinnoilla, käytettävissä olevilla reaalituloilla 15 vuotta täyttänyttä kohti ja tupakoinnin rajoittamistoimenpiteiden laajuutta kuvaavalla indeksimuuttujalla. Tämä indeksi saa arvon 0, jos maassa ei ole toteutettu mitään tupakointia rajoittavia toimenpiteitä ja arvon 100, jos maa on toteuttanut kaikki muuttujan kattamat toimenpiteet.

Kysyntää ja riippuvuutta selittäviin teorioihin nojautuen sovelsimme empiirisessä analyysissä perinteisiä staattisia malleja sekä dynaamisia osittaisen sopeutuksen ja rationaalisen riippuvuuden malleja. Pyrimme ottamaan huomioon muuttujien aikasarjaominaisuuksia soveltamalla myös virhekorjausmalleja. Staattiset mallit estimoitiin pienimmän neliösumman menetelmällä ja dynaamiset mallit instrumenttimuuttujamenetelmällä (2SLS). Virhekorjausmalleja estimoitaessa sovellettiin Englen ja Grangerin kaksivaiheista menetelmää.

Tulokset. Savukkeiden kysynnän lyhyen aikavälin hintajoustot olivat yleisesti –0,30 ja –0,40 välillä. Täten savukkeiden reaalihinnan korottaminen 1 % vähentää niiden kysyntää lyhyellä aikavälillä keskimäärin 0,3–0,4 %. Piippu- ja savuketupakan kysynnän lyhyen aikavälin hintajousto Suomessa oli –0,43, ja nuuskan kysynnän hintajousto Ruotsissa oli –0,24. Piippu- ja savuketupakan kysynnän ristijousto savukkeiden hinnan suhteen oli Suomessa 1,73. Jos savukkeiden reaalihintaa nostetaan 1 %:lla muiden tekijöiden pysyessä muuttumattomina, piippu- ja savuketupakan kulutuksen arvioidaan kasvavan 1,73 %. Tämä merkitsee sitä, että piippu- ja savuketupakka on Suomessa savukkeita korvaava tuote.

Savukkeiden kysynnän pitkän aikavälin hintajoustot vaihtelivat –0,21 ja –1,49 välillä ja tyypillinen joustoestimaatti oli noin –1,0. Pitkän aikavälin hintajoustojen

vaihtelu maiden välillä oli suurempaa ja estimaattien uskottavuus oli heikompi kuin lyhyen aikavälin hintajoustoilla.

Käytettävissä olevilla reaalituloilla oli positiivinen yhteys savukkeiden kulutukseen. Suurin osa saaduista tulojoustoista oli 0,10–0,60 välillä, mutta mediaani ja tyypillinen tulojousto oli suppeammalla välillä 0,30 ja 0,40. Käytettävissä olevien reaalitulojen kasvu 1 % lisää savukkeiden kulutusta keskimäärin 0,3–0,4 % muiden tekijöiden pysyessä vakioina. Käytettävissä olevien reaalitulojen kasvu vähentää piippu- ja savuketupakan kysyntää Suomessa ja Alankomaissa. Useimmissa tutkituissa maissa tupakoinnin rajoittamistoimenpiteiden laajuutta kuvaavalla muuttujalla oli negatiivinen yhteys savukkeiden kulutukseen. Jos uusien tupakoinnin rajoittamistoimenpiteiden tuloksena 0–100-indeksin arvo kasvaa tutkituissa maissa 10 pisteellä, savukkeiden kulutuksen arvioidaan vähenevän 2–3 %.

Johtopäätökset. Tulosten mukaan sekä hintapolitiikka että muut tupakoinnin rajoittamistoimenpiteet ovat selvästi olleet vaikuttavia toimia tupakankulutuksen vähentämiseksi. Tupakkapolitiikassa tulisi myös aiempaa enemmän ottaa huomioon myös muiden tupakkatuotteiden kuin savukkeiden vaikutus tupakan kokonaiskulutukseen ja sitä kautta terveyteen. Lisäksi sekä hintapolitiikassa että muussa tupakkapolitiikassa pitäisi ottaa huomioon kasvavien reaalitulojen vaikutus tupakkatuotteiden kulutukseen.

Avain sanat: tupakan kysyntä, tupakan kulutus, hintapolitiikka, tupakointia rajoittavat toimenpiteet, kysynnän ekonometrinen analyysi, ekonometriset mallit, jousto, aikasarjat, riippuvuus

Sammandrag

Lien Nguyen, Gunnar Rosenqvist, Markku Pekurinen. Demand for Tobacco in Europe. An Econometric Analysis of 11 Countries for the PPACTE Project [Ekonometrisk analys av efterfrågan på tobaksprodukter i 11 europeiska länder]. Institutet för hälsa och välfärd (THL). Rapport 6/2012. 172 sidor. Helsingfors, Finland 2012. ISBN 978-952-245-593-2 (tryckt)

Bakgrund. Prispolitiken anses vara det viktigaste medlet för att reducera konsumtionen av tobak. Vi har undersökt faktorer som kan förklara konsumtionen av tobaksprodukter per capita och möjligheten att reglera konsumtionen med hjälp av prispolitik i 11 europeiska medlemsstater.

Metoder. Materialet består av aggregerade tidsserier av årsdata som omfattar 30–60 år ända fram till 2009 och inbegriper Finland, Frankrike, Irland, Italien, Nederländerna, Portugal, Spanien, Storbritannien, Sverige, Tyskland, och Österrike. Cigaretter var den mest konsumerade tobaksprodukten i alla de undersökta länderna, medan pip- och cigarettobak och snus konsumerades i avsevärd omfattning i några av länderna. Konsumtionen av dessa produkter per capita förklaras i de landsspecifika analyserna med hjälp av realpriset på tobaksprodukter, den reella disponibla inkomsten per capita och ett index som beskriver de nationella åtgärdernas omfattning för att begränsa tobakskonsumtionen.

Utgående från teorier om efterfrågan och beroende tillämpas statiska modeller, modeller för partiell anpassning och modeller för rationellt beroende. På grund av variablernas tidsserieegenskaper används också felkorrigeringsmodeller. Vid estimeringen av dynamiska modeller tillämpas instrumentvariabler (2SLS) och Engle-Grangers tvåstegsmetod.

Resultat. Resultaten baserar sig på de estimerade modeller vars residualer antingen inte alls uppvisar autokorrelation eller också endast i liten mån. För majoriteten av länderna ligger den estimerade kortsiktiga priselasticiteten för cigaretter mellan –0,30 och –0,40 (dvs. en 10% ökning av det reella priset på cigaretter medför en 3–4% minskning av cigarettkonsumtionen). För pip- och cigarettobak i Finland ligger den estimerade kortsiktiga priselasticiteten på –0,43 och för snus i Sverige på –0,24. Pip- och cigarettobak framstår som ett substitut för cigaretter i Finland i och med den estimerade korspriselasticiteten på 1,73 (dvs. en 10% ökning av det reella priset på cigaretter föranleder en 17,3% ökning av konsumtionen av pip- och cigarettobak). Den långsiktiga priselasticiteten för efterfrågan på cigaretter i de prefererade modellerna ligger i de flesta fallen mellan –0,21 och –1,49 och har ett typiskt värde på omkring –1,0. Av tekniska orsaker uppvisar den långsiktiga elasticiteten större variation och mindre reliabilitet än den kortsiktiga elasticiteten.

En högre reell disponibel inkomst är förknippad med en högre konsumtion av cigaretter. De flesta estimaten av inkomstelasticiteten ligger mellan 0,10 och 0,60 med en median på mellan 0,30 och 0,40. En 10% ökning av den reella disponibla in-

komsten tenderar således att ge upphov till en ökning i konsumtionen av cigaretter med 3–4%. En högre reell disponibel inkomst är förknippad med en lägre konsumtion av pip- och cigarettobak i Finland och i Nederländerna. För flertalet av de undersökta länderna har det index som mäter omfattningen av åtgärderna för att begränsa tobakskonsumtionen en negativ koppling till konsumtionen av cigaretter. En ökning med 10 poäng (på skalan 0–100) i det index som beskriver åtgärderna för begränsning av tobakskonsumtionen innebär att konsumtionen av cigaretter minskar med 2–3%.

Slutsatser. Våra resultat visar klart att prispolitiken och andra åtgärder som syftar till att begränsa tobakskonsumtionen är effektiva metoder för att begränsa konsumtionen av cigaretter. Resultaten visar emellertid också att planeringen av tobakspolitiken bättre borde beakta de negativa hälsoeffekterna även av andra tobaksprodukter än cigaretter. Dessutom borde prispolitiken och övrig tobakspolitik beakta de ökande reella inkomsternas effekt på tobakskonsumtionen.

Nyckelord: efterfrågan på tobak, konsumtion av tobak, åtgärder för att begränsa rökningen, ekonometrisk analys av efterfrågan, ekonometriska modeller, elasticitet, tidsserier, beroende

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1 Introduction

Smoking has been commonly seen as the single largest preventable cause of disease and premature death (see e.g. Phillips et al. 1996) with tobacco recently being considered to be the world's leading cause of premature death (Frieden and Bloomberg 2007; see e.g. Jha 2009). Smoking is responsible for a considerable proportion of health care expenditure that imposes a substantial financial burden on health care in each country (Chaloupka and Warner 2000; U.S. Department of Health and Human Services 2004). It has been estimated that smoking caused around 25–30% of all cancer deaths in Europe (La Vecchia et al. 2003). Cohort studies show that compared to non-smoker counterparts, long-term smokers lose more than 10 years of life expectancy approximately (Doll et al. 2004). Furthermore, smoking has been seen as one of several key determinants of social inequality in health (Mackenbach et al. 2004).

Tobacco consumption is generally considered addictive and harmful to both smokers and other people. Smoking reduction would reduce premature mortality and morbidity, decrease the high incidence of smoking-related diseases, and reduce socioeconomic disparities in health (U.S. Department of Health and Human Services 2004). The WHO Framework Convention on Tobacco Control has established several vigorous measures and effective strategies to reduce the demand for tobacco, such as price and tax measures, protecting people from exposure to environmental tobacco smoke, the regulation and disclosure of the contents of tobacco products, comprehensive bans and restrictions on tobacco advertising, promotion and sponsorship, as well as tobacco dependence and cessation measures (Shibuya et al. 2003).

Among the available population-level tobacco control interventions for reducing smoking, some visible interventions such as health warnings and advertising restrictions are less supported by evidence than, for example, increasing of prices for tobacco products (Thomas et al. 2008). Other tobacco control interventions and policies, such as restrictions and bans on smoking in public places and hospitality establishments as well as restrictions on cigarette sales to adolescents, are expected to have significant health and economic consequences. There is consensus among tobacco control economists that tobacco excise tax increases are a very effective means of reducing tobacco consumption (World Bank 1999; Chaloupka and Warner 2000; Jha and Chaloupka 2000; IARC forthcoming). It has been found that demand for tobacco products responds to changes in product prices. Higher prices for cigarettes and other tobacco products have been found to significantly reduce overall consumption of those products not only at aggregate level but also at the individual level, as expressed by e.g. smoking prevalence, initiation, quitting or cessation, and level of consumption among smokers (Chaloupka and Warner 2000; Jha and Chaloupka 2000; Gallet and List 2003). Reviews examining the effects of tax and price on demand for tobacco products have incorporated evidence from studies using survey data at individual and household levels as well as studies using data at

aggregate levels in the form of time series and panel data (Chaloupka and Warner 2000; Gallet and List 2003; IARC forthcoming).

A large body of empirical studies exist that use aggregate data over several time periods, utilizing a variety of econometric techniques. In spite of this, only a small number actually look into e.g. the effects of prices and bans and/or restrictions on tobacco consumption in several European countries at the same time (Cox and Smith 1984; Laugesen and Meads 1991; Stewart 1993; Saffer and Chaloupka 2000; Escario and Molina 2001; Nelson 2003; Gallus et al. 2006). Furthermore, most of these studies merely performed one cross-country analysis of demand for tobacco using pooled country-specific annual data over a certain time period.

Cross-country analyses can shed helpful insights and place the experience of each country into a broader perspective. However, simple regression demand models using pooled aggregate data cannot be methodologically appropriate to control for large differences between countries. In contrast, we focus on each specific country included in the analysis. Furthermore, while many previous studies specify different types of dummy variables for the adopted tobacco control policies (see e.g., IARC forthcoming), a modified tobacco control policy index is used as an explanatory variable to measure and control for the magnitude of tobacco control policies implemented in each country (Joossens and Raw 2006). In addition to static specifications of demand functions, this study allows for tobacco addiction (not considered in many previous cross-country models), while also taking into account the properties of time-series data.

2 Aim of the study

The aim of this study is to explore the key factors that affect the aggregate demand for significant tobacco products (such as cigarettes, pipe and hand-rolling tobacco, and snus) in selected EU Member States. The main objective is to analyze the price elasticities of demand for the selected tobacco products in the selected EU countries and investigate whether cigarettes and pipe and hand-rolling tobacco or/and snus are substitutes. The second objective is to evaluate to what extent demand for tobacco products can be controlled by price measures. Thirdly, we would like to evaluate the consumption effects of tobacco control policies in these countries.

3 Theoretical framework

The starting point for the econometric endeavour to study the demand for tobacco products is based on economic theory. The economics of smoking with a focus on the demand for tobacco products and tobacco control policies, particularly the effect of pricing policy, as well as on alternative approaches to economic modelling of the demand for tobacco have been comprehensively reviewed previously (see e.g. Grossman et al. 1998; Chaloupka and Warner 2000; Chaloupka et al. 2000). On the other hand, Wilkins et al. (2003) have looked at more technical issues relating to the economic analysis of tobacco demand. Thus, here we only describe the essential economic concepts and the main economic approaches we have considered in this study.

One fundamental concept in economics is the law of demand. That is, there is a negative relationship between the price of a given commodity (or product or service) and the quantity demanded. This law of demand is derived from a constrained utility maximizing framework. Given an individual's preferences presented by a utility function and taking into account prices, income (a budget constraint) and other factors, a demand function for a given product can be derived where the quantity in demand negatively relates to the price of that product. An issue of interest in empirical studies is typically how the quantity demanded of the product will respond to changes in the prices. This responsiveness is captured by the price elasticity of demand, representing a percentage change in quantity demanded in response to a percent change in price, with all other factors being held constant.

The quantity of tobacco demanded theoretically responds to changes in monetary prices, and other costs as well as being influenced by income and factors describing tastes. It is assumed that the demand for a tobacco product is a function of its price, the prices of other products, and consumers' disposable income. In practice, the price variables are often restricted to close substitutes and complements. The conventional demand model is a static model specified as

$$(1) \qquad Q_{it} = f_i(P_{it}, P_{jt}, Y_t, \mathbf{Z}_t)$$

where i and j stand for two single tobacco products, and t stands for period. Q_{it} and P_{it} denote the per capita consumption of product i and its real price respectively; while P_{jt} is the real price of product j, and Y_t is the real disposable income per capita. Vector $\mathbf{Z}_t$ accounts for other factors that are thought to affect the consumption of tobacco product i, in particular tobacco control policies, such as bans and restrictions on smoking in public and work places, increased information on the health risks of smoking, public information campaigns, bans on advertising and promotion of tobacco products, warning labels on cigarette boxes and other tobacco products and treatment to help dependent smokers quit.

With a contemporaneous specification (1), the current demand specified by the conventional model is a function of current prices and income as well as other relevant explanatory variables. Addictive behaviour in consumption of a tobacco product has been modelled through backward-looking myopic addiction models, also called partial adjustment models, as well as through forward-looking rational addiction models (Becker et al. 1994; Becker and Murphy 1988). In the partial adjustment models, past consumption influences current consumption, while in the rational addiction models, not only past consumption but also future consumption affects current consumption.

The addiction approach attempts to model three dimensions of addiction—tolerance, reinforcement and withdrawal—which are associated with the consumption of addictive goods (see Ashton and Stepney 1982; Chaloupka 1988). Tolerance suggests that a given level of current consumption is less satisfying (lower utility) as cumulative past consumption is higher. Reinforcement reflects consumers' learned responses to consumption and rewards related to it. Withdrawal indicates the negative physical and mental reactions to quitting smoking and reducing or interrupting consumption. Addiction implies that current consumption decisions are dependent upon past consumption choices and past consumption increases the marginal utility of current consumption.

In addition to reflecting the dependence of current consumption decisions on past consumption behaviour, the rational addiction model of consumption of an addictive good also considers the future consumption implications when making current consumption decisions (Becker and Murphy 1988). The consumption of an addictive good is assumed to display 'adjacent complementarity' (Becker et al. 1991; Becker and Murphy 1988). Due to reinforcement, the quantities of the addictive good demanded in different time periods are complements. In turn, this implies that current consumption of the addictive good will be inversely related to all the current, past and future prices of the good. Past consumption will have a larger impact on current consumption than future consumption, and the long-run effect of a permanent change in the price of the addictive product will exceed the short-run effect. In addition, the effect of an anticipated change in the price of that product will be higher than the effect of an unanticipated change in the price.

4 Econometric models

To estimate price and income elasticities of demand for tobacco, the typical starting point is to specify a demand equation. In this study, we have applied both the conventional (static) model and the addiction model (partial adjustment and rational addiction models) as well as error correction models. Writing the conventional demand model (1) as a linear equation, we get

$$(2) \qquad Q_t = \alpha_0 + \alpha_1 P_t + \alpha_2 P_{jt} + \alpha_3 Y_t + others_t + \varepsilon_t$$

where the dependent variable Q_t is per capita consumption of a given tobacco product, while P_t is the real price of the tobacco product, and P_{jt} is the real price of other tobacco products, Y_t is the real disposable income per capita, and ε_t is the error term. Parameters α_1, α_2, and α_3, which are associated with variables P_t, P_{jt}, and Y_t, are coefficients to be estimated. 'Others$_t$' stands for those factors that are thought to affect the consumption of the tobacco product described by vector $\mathbf{Z_t}$ in equation (1).[1]

The partial adjustment model or the myopic addiction model can be specified as

$$(3) \qquad Q_t = \alpha_0 + \alpha_1 P_t + \alpha_2 P_{jt} + \alpha_3 Y_t + \alpha_4 Q_{t-1} + others_t + \varepsilon_t$$

where $0 < \alpha_4 < 1$, the lagged consumption variable Q_{t-1} is the per capita consumption of the tobacco product in the period previous to t, with the other variables being the same as in model (2). Tobacco use is addictive if $\alpha_4 > 0$, and the degree of addiction is greater when α_4 is larger.

The coefficient on past consumption Q_{t-1}, α_4, can be also interpreted as the speed of adjustment to the steady state level or desired level of consumption (Baltagi and Lewin 1986). The smaller is α_4, the greater is the partial adjustment factor $(1 - \alpha_4)$ and the faster actual demand will reach the steady state or desired level. In a case where a log-log specification is used, i.e., both dependent and explanatory continuous variables are log-transformed, then constant elasticity estimates of demand for a given tobacco product can be easily derived from the estimated model. For example, specified as (3), the estimated coefficient α_1 is the short-run price elasticity, while the long-run price elasticity is equal to $\alpha_1 / (1 - \alpha_4)$. The long-run price elasticity is assumed to be greater, in absolute terms, than the short-run price elasticity, indicating that a change in the current price will have a larger impact on consumption in the long run than in the short run.

The partial adjustment model (3) takes into account the addictiveness of tobacco by including the lagged dependent variable in the estimation equation. This

[1] As 'others$_t$' is written in simple form here, it implicitly means that there are coefficients to be estimated that are associated with factors included in 'others$_t$'.

econometric method is a standard technique that is based on the concept of persistence habit (Houthakker and Taylor 1970; Fujii 1980; Baltagi and Lewin 1986).

In the rational addiction model proposed by Becker and Murphy (1988), the focus is on future consumption (or future prices) in explaining current consumption. A simple version of the rational addiction model can be written as

$$(4) \qquad Q_t = \alpha_0 + \alpha_1 P_t + \alpha_2 P_{jt} + \alpha_3 Y_t + \alpha_4 Q_{t-1} + \alpha_5 Q_{t+1} + others_t + \varepsilon_t$$

where $0 < \alpha_5 < \alpha_4 < 1$ and $\alpha_4 + \alpha_5 < 1$, the lead consumption variable Q_{t+1} is the per capita consumption of the tobacco product in the period following t, with the other variables being the same as in model (3).[2] In a case where a log-log functional form is used for model (4), the estimated coefficient α_1 is the short-run price elasticity and the long-run price elasticity is equal to $\{\alpha_1 / [1 - (\alpha_4 + \alpha_5)]\}$ where $[1 - (\alpha_4 + \alpha_5)]$ is the partial adjustment factor.

The rational addiction model (4) assumes that current consumption does not only depend on consumption that occurred in the previous period but also on future anticipated consumption that would occur in the following period. If tobacco is an addictive good, current tobacco consumption Q_t is expected to be positively associated with past consumption Q_{t-1} and future consumption Q_{t+1}. The coefficients on past consumption Q_{t-1}, α_4, and on future consumption Q_{t+1}, α_5, can be used to test for whether consumers are addicted or not, and whether they are myopically or rationally addicted. Myopic addiction or partial adjustment would imply that only the parameter α_4 is statistically significant, whereas rational addiction would also suggest that the parameter α_5 is statistically significant. If tobacco consumption is rationally addictive, the long-run price elasticity obtained will be greater than the corresponding long-run price elasticity obtained when tobacco consumption is partially adjusted (or myopically addictive).

Equations (3) and (4) are one basis of the empirical analysis in this study. Given that past and future consumption Q_{t-1} and Q_{t+1} are endogenous in equation (4) and past consumption Q_{t-1} in equation (3), using ordinary least squares to estimate equations (3) and (4) would lead to inconsistent estimates of the parameters of interest (e.g. Becker et al. 1994). To address this issue, assuming that the unobserved errors are not correlated with prices in periods t–1 and t+1, past and future prices can be used as instruments for past and future consumption (see further the Estimation strategies).

[2] In less restrictive versions of the rational addiction model, lagged and lead prices are also included in the right-hand side of the equation, e.g. $Q_t = \alpha_0 + \alpha_1 P_t + \alpha_2 P_{t-1} + \alpha_3 P_{t+1} + \alpha_4 Q_{t-1} + \alpha_5 Q_{t+1} + \varepsilon_t$.

The fourth demand model we have applied is the error correction model, which in a simple version is specified as

$$(5) \qquad \Delta Q_t = \beta_0 + \beta_1 \Delta P_t + \beta_2 \Delta P_{jt} + \beta_3 \Delta Y_t + others_t + \pi \varepsilon_{t-1} + \upsilon_t$$

where Δ is the difference operator, for example, $\Delta Q_t = Q_t - Q_{t-1}$, and υ_t is the error term. ε_t is the equilibrium equation, which is defined by means of equation (2) as $\varepsilon_t = Q_t - \alpha_0 - \alpha_1 P_t - \alpha_2 P_{jt} - \alpha_3 Y_t - others_t$.[3] To revert to equilibrium, the adjustment coefficient π is expected to have a negative sign ($\pi < 0$). In this case, the conventional model (2) describes the equilibrium relationship between consumption and the explanatory variables, whereas the error correction model (5) explains the short-run relationship between those variables. If a log-log specification is used for both models (2) and (5), the estimated coefficient β_1 in model (5) is the short-run price elasticity, while the estimated coefficient α_1 in model (2) is the price elasticity for the equilibrium equation ε_t. General versions of the error correction model of demand may have more consumption lags such as ΔQ_{t-1}, ΔQ_{t-2}, ΔQ_{t-3}, ... appearing as explanatory variables on the right-hand side of equation (5).

[3] The explanatory variables included in vector '$others_t$' are also in form of 1st difference in equation (5).

5 Data and variable specifications

Econometric analysis of the type performed in this study requires sufficiently long time series. Therefore, the availability of data steered our selection of countries. The present study involved eleven EU Member States: Austria, Finland, France, Germany, Ireland, Italy, the Netherlands, Portugal, Spain, Sweden, and the United Kingdom.[4] Three types of tobacco products were considered: cigarette, pipe and hand-rolling tobacco, and snus. The primary dependent variable was cigarette consumption per capita (an adult aged at least 15 years old). In addition, the second dependent variable was per capita consumption of pipe and hand-rolling tobacco in Finland, Germany, and the Netherlands, and per capita consumption of snus in Sweden. Table 1 contains the study countries, aggregate data periods and dependent variables in each country-specific data set.

Table 1. Study countries, aggregate data periods and dependent variables

Country	Data period	Dependent consumption variable		
		Cigarettes (sticks)	Pipe and hand-rolling tobacco (g)	Snus (g)
Austria	1976–2009	x		
Finland	1960–2009/1960–2002#	x	x	
France	1950–2009	x		
Germany	1960–2009	x	x	
Ireland	1970–2009	x		
Italy	1970–2009	x		
Netherlands	1980–2009	x	x	
Portugal	1970–2009	x		
Spain	1960–2009	x		
Sweden	1955–2009	x		x
United Kingdom	1953–2009	x		

Note. Consumption was measured as annual consumption per capita (a person aged at least 15 years old).

No information on consumption of pipe and hand-rolling tobacco in Finland has been available since 2003.

Tax paid annual sales data or industry data of actual release into the domestic market were used as proxies for each tobacco product's annual consumption in our aggregate tobacco demand models. For each country, per capita consumption of to-

[4] Countries included in the study are those European countries for which we managed to get appropriate data.

bacco product was obtained by dividing total annual product-specific tobacco sales by the adult population. Per capita tobacco consumption in the country-specific data is assumed to reflect the behaviour of a representative consumer in that country. Mean annual adult population age 15 and over were obtained from the country's national statistics office for seven countries including Finland, France, Germany, Ireland, the Netherlands, Sweden, and the United Kingdom and from EuroStat online databases (http://epp.eurostat.ec.europa.eu/portal/page/portal/eurostat/home) for the other four countries (Austria, Italy, Portugal, and Spain).

The primary data sources used for this study are introduced in Table 2. The consumer price index was obtained either from the national statistics offices or from OECD online databases (http://stats.oecd.org/). All information on tobacco products' retail prices or retail price indices was obtained from the national statistics offices, except for information on the prices of cigarette packs for the period 1960–1975 in Spain's statistical analysis, which were provided by the Tobacco Market Commission (www.cmtabacos.es). We used disposable household income collected directly from the national statistics offices for eight countries including Austria, Finland, France, Germany, Ireland, the Netherlands, Sweden, and the United Kingdom. However, we had to use net national disposable income that was collected from the OECD online databases for Italy and Portugal and from the AMECO databases for Spain. In general, time-series data on price and income variables for 15–25 years were obtained directly online from the national statistics offices' websites, while longer expanded time-series data were provided by statistical advisors from several national statistics offices by contacting them directly. In addition to official information, some corrections were done for Germany's,[5] Ireland's,[6] Italy's,[7] and Portugal's[8] data.

[5] Due to the reunification of Germany in 1990, no consumption information has been available for the year 1990. Consumption of each tobacco product in 1990 in Germany was constructed as the mean consumption of both the years 1989 and 1991.

[6] For Ireland, manufactured cigarettes consumed in 1970–1976 were counted in lbs, but if each cigarette is counted as weighing a nominal 1 g of tobacco, the consumption figures for that period seem to be very small compared to the following years. Since there was no increase in excise duty in 1978, accordingly the number of cigarettes in 1978 was pro rata to the excise. This gave us the formula to check the number of cigarettes in 1977 in relation to the number of cigarettes in 1978. The ratio of the former to the latter was used to convert the cigarette consumption in lbs in 1977 to the number of cigarettes in 1978. We then used this as a basis to convert the consumption in lbs to the number of cigarette for years before 1977. We thank Mick Gaffney (Revenue – Irish Tax and Custom) for pointing out the information on no change in excise duty in Ireland in 1978.

[7] For Italy, the data were based on the sum of both foreign and national cigarettes with the total number of cigarettes consumed in 1981 acting as the base line to chain the consumption figures backwards since 1981.

[8] For Portugal, the consumption data were based on apparent consumption (production plus imports minus exports).

Table 2. Data sources used in this study

Country	Availability	Source				
		Tobacco products' consumption	Consumer price index	Price	Disposable income	Population
Austria	1976–2000	USDA FAS		Statistics Austria		EuroStat
	2001–2000	Ministry of Finance		Statistics Austria		EuroStat
Finland	1960–2009	Finland Statistics (Tilastokeskus 1988, 2010)				
France	1950–2003	Hill & Laplanche (2003)	OECD	Hill & Laplanche (2003)	National Institute of Statistics and Economic Studies (INSEE)	
	2004–2009	Altadis/DGDDI	OECD	INSEE	INSEE	INSEE
Germany	1960–1989	German Federal Statistical Office				
	1991–2009	German Federal Statistical Office				
Ireland	1970–2009	Revenue – Irish Tax & Customs	Central Statistics Office of Ireland (CSO)			
Italy	1970–1990	National Institute of Statistics (ISTAT)	OECD	ISTAT	OECD	EuroStat
	1990–2009	ISTAT	OECD	ISTAT	OECD	EuroStat
Netherlands	1980–2009	Statitistics Netherlands (CBS)				
Portugal	1970–2009	Statistics Portugal (INE)			OECD	EuroStat
Spain	1960–1975	Tobacco Market Commision (CMT)	OECD	CMT	AMECO	EuroStat
	1975–2009	CMT	OECD	National Statistics Institute (INE)	AMECO	EuroStat
Sweden	1955–2009	Statistics Sweden (SCB)				
United Kingdom	1953–2009	Tobacco Manufacters' Association (TMA)	Office for National Statistics (ONS)			

Note.

AMECO database = Annual macro-economic database

EuroStat = Statistical Office of the European Communities

OECD = Organization for Economic Cooperation and Development

DGDDI = Direction générale des douanes et droits indirects (Directorate General for customs and excise)

USDA FAS = United States Department of Agriculture, Foreign Agricultural Service

Table 3 introduces explanatory economic variables used in the empirical models of demand for tobacco products. Per capita disposable income was obtained by dividing the corresponding disposable income by the number of population aged at least

15 years old. The per capita disposable income and the respective retail price index series were deflated by the consumer price index to get the real terms.

In addition to price and income, various population-level tobacco control interventions also affect tobacco use. To economize on the degrees of freedom of models, we attempt to pick up the whole of the effects of diverse tobacco control policies in a single variable. A tobacco control scale (TCS) score or the so-called tobacco control policy (TCP) index, which is constructed and modified following Joossens and Raw's (2006) original TCS, is used as an explanatory variable in all the empirical models (Appendix A).

Table 3. Price and income variables used in the study

Country	Explanatory variable					
	Real price index				Real disposable income	
	Cigarettes	Pipe and HRT	Snus	Tobacco	Household	Net national
Austria	x				x	
Finland	x	x			x	
France	x				x	
Germany	x	x			x	
Ireland[a]	x				x	
Italy				x		x
Netherlands	x	x			x	
Portugal				x		x
Spain[b]				x		x
Sweden	x		x		x	
United Kingdom[c]	x				x	

Note. HRT = Hand-rolling tobacco

[a] For Ireland, we used price index of tobacco for the period 1970–1975 and price index of cigarettes for 1976–2009.

[b] For Spain, we used price of a 20-cigarette pack for 1960–1975 and price index of tobacco for 1976–2009.

[c] For United Kingdom, we used price index of tobacco for 1953–1973 and price of cigarettes for 1974–2009.

The original TCS is seen as an attempt to systematically measure the overall magnitude of the implemented tobacco control policies at country level (Joossens and Raw 2006). The original scale of 100 points is based on six tobacco control policies: [1st policy] price of cigarettes and other tobacco products (total 30 points), [2nd policy] smoke-free workplace and other public places (total 22 points), [3rd policy] spending on public information campaigns (total 15 points), [4th policy] comprehensive bans on advertising and promotion (total 13 points), [5th policy] large direct health warning labels (total 10 points), and [6th policy] treatment to help dependent smokers quit (total 10 points).

The TCP index did not incorporate two policies: price as well as spending on public information campaigns (that is, 1st policy and 3rd policy). The price of a to-

bacco product, which is our main variable of interest and the focus of these demand analyses for deriving price elasticity estimates, is separately included into all the empirical models as an explanatory variable. In addition, information on annual spending on national tobacco control campaigns was not available for long periods of time for all study countries. Therefore, to construct the TCP index, the following four policies (having in total 55 points in the original TCS) were used: 2nd policy, 4th policy, 5th policy, and 6th policy (see the six policies listed above and Appendix B).

In this study, scores published in 2005 and 2007 were only used as a reference (Joossens and Raw 2007), while multiple sources were consulted to expand the scores forwards in time to 2009 and backwards in time to the start of the tobacco control policies included in this measure. Sources consulted include the relevant literature and reports as well as the World Health Organization (WHO) tobacco control database, involving also corroboration from several national tobacco control correspondents (see Appendix A). The final TCP index for each country was obtained by converting the total score each country received according to the original scoring system (Joossens and Raw 2007) to the range 0–100. Since the TCS score is based on what was deemed 'best practice' in 2005, it does not allocate partial points for partial restrictions but only for comprehensive bans. Hence, while the TCS score can be useful for most recent years, it may become less relevant the further back we go. Furthermore, all countries had a zero score before 1970, which was about the time when smoke-free policies and tobacco control interventions were starting to be implemented (IARC 2009). The TCS scores used in the country-specific analyses are presented in Table 4.

The modified TCS score enables us to quantify the implementation of tobacco control policies at country level from 1970 onwards. As an alternative traditional approach to describing the impacts of tobacco control policies on tobacco consumption, dummy variables have been used as explanatory variables in the empirical demand models. In addition, dummy variables can be used to describe the impacts of those policies and interventions that were implemented earlier than 1970, as well as those interventions not included in the TCS variable.

The literature suggests three types of dummy variables. The first indicate limited duration effects, which have a value of one in the year of a policy measure (health education, health scare, health campaigns etc.) and for a specified number of years after the particular event (see Witt and Pass 1981). This dummy variable captures the immediate though short-lived effect that the measure has had on consumption. The second type of dummy variable describes permanent effects: the specified dummy variable has a value of one in the year of the measure and all subsequent years. This practice suggests that a particular measure results in an effect that extends beyond the immediate effect on consumption during the year in which it occurs and is permanent. This generally reflects the view that the resulting effects are not just fleeting but irreversible. The third type of dummy variable combines a permanent effect with a time trend (to capture a relapse or a growth rate), which is defined by R = 1, 2, 3, … for the years following the measure. This dummy variable accounts for

Table 4. The tobacco control scale scores in eleven EU countries, 1970–2009

Year	Aus-tria	Fin-land	France	Ger-many	Ireland	Italy	Nether-lands	Portu-gal	Spain	Swe-den	United King-dom
1970	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	5.5	0.0
1971	0.0	0.0	0.0	0.0	5.5	0.0	0.0	0.0	0.0	5.5	0.0
1972	0.0	5.5	0.0	0.0	5.5	0.0	0.0	0.0	0.0	5.5	0.0
1973	0.0	5.5	0.0	0.0	5.5	0.0	0.0	0.0	0.0	5.5	0.0
1974	0.0	5.5	0.0	6.4	5.5	0.0	0.0	0.0	0.0	7.3	0.0
1975	1.8	5.5	1.8	6.4	5.5	7.3	0.0	0.0	0.0	7.3	0.0
1976	1.8	5.5	1.8	6.4	5.5	7.3	0.0	0.0	0.0	7.3	0.0
1977	1.8	36.4	1.8	6.4	5.5	7.3	0.0	0.0	0.0	7.3	0.0
1978	1.8	36.4	1.8	6.4	5.5	7.3	0.0	0.0	0.0	7.3	0.0
1979	1.8	36.4	1.8	6.4	5.5	10.9	0.0	0.0	0.0	7.3	0.0
1980	1.8	36.4	1.8	6.4	5.5	10.9	0.0	0.0	0.0	7.3	0.0
1981	1.8	36.4	1.8	6.4	5.5	10.9	0.0	0.0	0.0	7.3	0.0
1982	1.8	36.4	1.8	8.2	5.5	10.9	0.0	0.0	0.0	7.3	0.0
1983	1.8	36.4	1.8	8.2	5.5	24.5	0.0	22.7	0.0	7.3	0.0
1984	1.8	36.4	1.8	8.2	5.5	30.0	0.0	22.7	0.0	7.3	0.0
1985	1.8	36.4	1.8	8.2	5.5	30.0	0.0	22.7	0.0	7.3	0.0
1986	1.8	36.4	1.8	8.2	6.4	30.0	0.0	22.7	0.0	12.7	0.0
1987	1.8	36.4	1.8	8.2	6.4	30.0	0.0	22.7	0.0	12.7	3.6
1988	1.8	36.4	1.8	8.2	6.4	30.0	0.0	22.7	3.6	12.7	3.6
1989	1.8	36.4	1.8	8.2	6.4	30.0	0.0	22.7	9.1	12.7	9.1
1990	1.8	36.4	1.8	8.2	6.4	30.0	15.5	22.7	9.1	12.7	9.1
1991	1.8	36.4	24.5	13.6	10.0	33.6	15.5	28.2	18.2	14.5	16.4
1992	1.8	43.6	28.2	13.6	17.3	33.6	15.5	28.2	21.8	14.5	23.6
1993	1.8	43.6	28.2	13.6	17.3	40.9	15.5	28.2	21.8	14.5	23.6
1994	1.8	47.3	28.2	13.6	17.3	40.9	15.5	28.2	27.3	50.9	23.6
1995	17.3	47.3	28.2	13.6	22.7	44.5	15.5	28.2	27.3	50.9	23.6
1996	17.3	47.3	28.2	13.6	22.7	44.5	26.4	29.1	29.1	50.9	23.6
1997	17.3	47.3	28.2	13.6	22.7	44.5	26.4	29.1	29.1	50.9	23.6
1998	17.3	47.3	28.2	13.6	22.7	44.5	26.4	29.1	29.1	54.5	23.6
1999	17.3	49.1	35.5	19.1	24.5	48.2	26.4	29.1	29.1	54.5	27.3
2000	17.3	56.4	35.5	19.1	26.4	48.2	30.0	29.1	29.1	58.2	27.3
2001	17.3	56.4	35.5	19.1	28.2	48.2	30.0	29.1	30.9	58.2	30.9
2002	22.7	61.8	35.5	22.7	30.9	50.0	41.8	32.7	34.5	58.2	30.9
2003	26.4	67.3	50.0	26.4	40.0	53.6	45.5	38.2	34.5	61.8	45.5
2004	26.4	67.3	50.0	26.4	81.8	53.6	60.0	38.2	34.5	61.8	45.5
2005	30.0	68.2	53.6	26.4	86.4	75.5	60.9	42.7	35.5	75.5	51.8
2006	38.2	68.2	53.6	27.3	86.4	75.5	60.9	42.7	73.6	75.5	68.2
2007	46.4	68.2	66.4	46.4	86.4	75.5	60.9	42.7	73.6	75.5	88.2
2008	47.3	72.7	76.4	50.0	87.3	75.5	69.1	61.8	74.5	76.4	94.5
2009	50.9	78.2	76.4	50.0	89.1	75.5	69.1	61.8	74.5	76.4	94.5

Source: See Appendix A.

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the erosion (or intensification) of the initial effect of the measure on consumption, i.e., it allows for the initial impact of the health measure to change (fade or grow) in subsequence years. These three types of dummy variables were used as explanatory variables in the tobacco demand equations of several studies (e.g. Jones 1989; Pekurinen 1989, 1992; Duffy 1996).

We assume that our modified TCS score variable substitutes all dummy variables describing tobacco control policies from 1970 onwards. However, for six countries (Finland, France, Germany, Spain, Sweden, and the United Kingdom), our time series began before 1970. After checking the tobacco control policy data obtained from each country and as following the literature, in addition to the TCS variable, we included in the models two one-year limited duration variables (D1960 and D1964), which capture the effects of 'health scares' (or health education) for Sweden as well as a similar one-year dummy variable (D1964) for Finland. In Sweden, in 1960 the tobacco monopoly published a brochure warning that heavy consumption of cigarettes can contribute to the development of lung cancer and in 1964 the government made the first allocation for public information on the harmful effects of tobacco (Swedish tobacco control <http://www.tobaccoorhealthsweden.org>). In Finland, following the publication of the Terry report in 1964 (U.S. Department of Health, Education, and Welfare 1964), the National Board of Health immediately published a short report on the health risks of smoking, and under this board's auspices a considerable information campaign was undertaken.

To the demand models of the United Kingdom, we included four dummy variables D1962, D1971, D1977, and D1983, and four time-trend variables R1963, R1972, R1978, and R1984, following the Atkinson-Skegg approach (1973). The combination of dummy and recovery-trend variables has been used in practice in several previous British studies (Duffy 1996; Jones 1989; Witt and Pass 1984). The four years 1962, 1971, 1977, and 1983 were singled out as containing significant health events in the United Kingdom that coincided with the publication of the four Royal College of Physicians' (RCP) reports on smoking and health. Our four dummy variables D1962, D1971, D1977, and D1983 are expected to describe reduction in consumption at the time of publication. The four trend variables R1963, R1972, R1978, and R1984 were used to allow for effects of a gradual return to previous levels of consumption following the time of publication of each RCP report as the health scare wears off in smokers' memories. All the dummy and trend variables specified for the tobacco control policies implemented in each country that could be used traditionally as explanatory variables in the empirical demand models are introduced in Appendix C. Table 5 presents definitions for all the variables and the anticipated directions of the effects of the explanatory variables on each dependent variable.

Table 5. Variables and expected signs of the effects of the explanatory variables on consumption of tobacco products

Variable	Definition	*A priori* expectation		
		Ciga-rettes	Pipe and hand-rolling tobacco	Snus
Dependent variable				
Q_{st}	Number of cigarettes consumed in the current year			
Q_{pt}	Quantity of pipe and hand-rolling tobacco consumed in the current year (g)			
Q_{snust}	Quantity of snus per capita consumed in the current year (g)			
Explanatory variable				
Price, income and consumption				
P_{st}	Real price of cigarettes	–	+	+
P_{pt}	Real price of pipe and hand-rolling tobacco	+	–	
P_{snust}	Real price of snus	+		–
Y_t	Real disposable income per capita	+	+	+
Q_{st-1}	Number of cigarettes per capita consumed in the previous year	+		
Q_{st+1}	Number of cigarettes per capita consumed in the following year	+		
Q_{pt-1}	Quantity of pipe and hand-rolling tobacco per capita consumed in the previous year (g)		+	
Q_{pt+1}	Quantity of pipe and hand-rolling tobacco per capita consumed in the following year (g)		+	
$Q_{snust+1}$	Quantity of snus per capita consumed in the following year (g)			+
$Q_{snust+1}$	Quantity of snus per capita consumed in the following year (g)		+	+
Tobacco control				
For all eleven countries				
TCS_t	Magnitude of tobacco control policies implemented in the country	–	?	?
For Finland				
D1964	Health education	–	–	
	= 1 for 1964; 0 otherwise			
For Sweden				
D1960	Health education	–		–
	= 1 for 1960; 0 otherwise			
D1964	Health education	–		–
	= 1 for 1964; 0 otherwise			

Table 5. *Continued*

Variable	Definition	*A priori* expectation		
		Ciga-rettes	Pipe and hand-rolling tobacco	Snus
For United Kingdom				
D1962	First Report by Royal College of Physicians = 1 for 1962 onwards; 0 otherwise	–		
D1971	Second Report by Royal College of Physicians = 1 for 1971 onwards; 0 otherwise	–		
D1977	Third Report by Royal College of Physicians = 1 for 1977 onwards; 0 otherwise	–		
D1983	Fourth Report by Royal College of Physicians = 1 for 1983 onwards; 0 otherwise	–		
Control variable				
For Finland				
D1992	Economic depression period = 1 for 1992, 1993 and 1994; 0 otherwise	–	–	
For United Kingdom				
R1963	Relapse rate = 0 prior to 1963 = 1, 2, …, 8 for 1963 to 1970 = 9 for 1971 onwards	+		
R1972	Relapse rate = 0 prior to 1972 = 1, 2, …, 5 for 1972 to 1976 = 6 for 1977 onwards	+		
R1978	Relapse rate = 0 prior to 1978 = 1, 2, …, 5 for 1978 to 1982 = 6 for 1983 onwards	+		
R1984	Relapse rate = 0 prior to 1983 = 1, 2, …, 3 for 1984 to 1986 = 4 for 1987 onwards	+		

Another way to control for the overall impacts of the implemented tobacco control policies on tobacco consumption is to use information on expenditure spent on anti-smoking measures (such as health education activities, media campaigns, prevention and research, and health care services) to reduce smoking and to promote health. Since this kind of information is not generally available for extended periods of time

for all study countries, we were not able to take account of this information (also noted above). Nevertheless, we believed that we did account for the impacts of the tobacco control policies on tobacco consumption by including in the country-specific demand models the TCS variable and additionally, several dummy and trend variables for three countries: Finland, Sweden and the United Kingdom. Since Finland suffered from a deep economic depression in the first half of the 1990s, the impact of the economic depression on tobacco consumption was taken into account by the three-year dummy variable 'D1992'. Figures 1–15 (found in the country-specific analyses) present per capita annual consumption and real prices of tobacco products consumed in the eleven study countries (see Results).

6 Estimation strategies

An important issue often addressed in the econometric literature is how to distinguish between the supply and demand of a given product (see e.g. Wilkins et al. 2003). Any movement in the equilibrium point, where the supply and demand curves cross and the price-quantity combination is established, can be the result of a change in the supply curve or in the demand curve or in both curves. Due to this potential problem of identification, a system approach is advised so as to identify the demand curve.

In general, demand and supply in markets are determined simultaneously and it is then not immediately obvious whether a model fitted to quantity and price data depicts the demand or the supply function. However, tobacco markets are typically not perfect. Usually, there are only a limited number of suppliers on the market and price is largely determined by taxes. Often, price is assumed to be exogenous to consumption and observed data on price and consumption then lies on the demand curve. Identification issues for tobacco demand models are discussed by e.g. Bishop and Yoo (1985) and Wilkins et al. (2003).

In this study, the conventional models are estimated by ordinary least squares (OLS). It can be assumed that either price or both past and future consumption variables are endogenous (Wilkins et al. 2003). We assume that the prices of the tobacco products in the selected EU countries are heavily controlled by governments and thus are assumed to be exogenous. However, given that the partial adjustment model indicates endogeneity of past consumption and the rational addiction model involves the endogeneity of past and future consumption, using the OLS method would lead to biased and inconsistent estimates. Therefore, we estimate the partial adjustment and rational addiction demand models (i.e., both the addiction models) for each tobacco product by the two-stage least squares (2SLS) method. Because prices are strongly correlated with consumption, we believe that they are suitable instruments for consumption. In the partial adjustment models, we use as instruments two lags of own price plus the other explanatory variables. In the rational addiction models, we use as instruments two lags and two leads of own price plus the other explanatory variables.

Since we will be analyzing time-series data, there is the danger of having spurious regression if the variables used are non-stationary (see e.g. Enders 2010). A stationary time series is one whose statistical properties such as mean, variance, autocorrelation etc. are all constant over time. A series with a trend, either deterministic or stochastic, is an example of a non-stationary series. If the trend is stochastic, the variance increases with time. A stationary time series implies that no trend is observed in the series. A time series can be trend-stationary, basically meaning that it is stationary around its deterministic time trend. A variable is said to be integrated of order one, I(1), if it becomes stationary after differencing once, i.e., $\Delta x_t = x_t - x_{t-1}$ is

stationary. Because a stationary series does not need to be differenced, it is said to be integrated of order zero, I(0).

It is of importance to realize the risk of spurious results because of unaccounted trends in time series. For example, Hendry and Juselius (2000) point out that when regressing one I(1) variable on another I(1) variable, the typical critical value on 5% level of significance in the usual t-test of the regression coefficient exaggeratedly shifts from about 2 to 14.8! Under the null hypothesis of no relation, the distribution of the t-test statistic in the usual t-test explodes. In fact, it no longer follows a t-distribution. Then, one is very likely to find a relation between the variables although there is no such relation.

To account for the nature of the time-series variables analyzed, we examined whether the individual data series are stationary or not. All time-series variables of interest were found to be non-stationary I(1) and their first differences stationary I(0) (Appendices D1–D11). These test results not only imply a risk of spurious relations for the three models with the variables in level form, particularly for the conventional model, but also suggest that the error correction model is well motivated.

We use the Augmented Dickey-Fuller test for cointegration to check for stationary residuals out of the estimated equation of the conventional model (2) for each tobacco product (Table 6). When the estimated residuals are stationary, cointegration can be established for the demand equation of each significant tobacco product. Following this, an error correction model can be set up and is estimated using the Engle-Granger two-step OLS method (Engle and Granger 1987).

Results from a meta-analysis of the demand elasticities showed that the conventional, partial adjustment and rational addiction models introduced have mostly been estimated by OLS and 2SLS methods (56.4% and 33.1%) (Gallet and List 2003). In addition, the log-log (double log) and linear-linear specifications have mostly been employed—the former being more frequently applied than the latter (54.3% and 44.2%)—and the semi-log specification is very rarely used (1.5%) (Gallet and List 2003). In this study, we used the log-log specification for all the estimated models. Using this functional form, the coefficients of the log-transformed continuous explanatory variables obtained from the estimated models can be directly interpreted as elasticities, with the elasticities being constant.

We have applied various diagnostic tests to the fitted models. Among these, we have paid particular attention to tests for autocorrelation in residuals that are reported in the result tables as Ljung-Box Q(1) (test for autocorrelated residuals with one lag included) and the Breusch-Godfrey Lagrange-multiplier test AR(2) (test for autocorrelated residuals with two lags included). When the test statistics are significant, they signal that the dynamics in the data are not well captured by the estimated model, implying unreliability in the estimation results. In particular, models that use non-stationary variables but do not take care of the non-stationarity are expected to show significant autocorrelation in the residuals.

Table 6. Testing stationary of residuals of the long-run (equilibrium) equations

Country	Long-run demand equation	Coefficient	ADF test statistic	Number of observations	Are residuals stationary?
Austria 1976–2009					
	Consumption of cigarettes	–0.486	–3.312	33	Yes
Finland 1960–2009/1960–2002					
	Consumption of cigarettes	–0.361	–3.252	49	Yes
	Consumption of pipe and hand-rolling tobacco	–0.422	–3.375	42	Yes
France 1950–2009					
	Consumption of cigarettes	–0.156	–2.215	59	Yes
Germany 1960–2009					
	Consumption of cigarettes	–0.355	–3.258	49	Yes
Ireland 1970–2009					
	Consumption of cigarettes	–0.154	–2.425	39	Yes
Italy 1970–2009					
	Consumption of cigarettes	–0.139	–1.671	39	Yes[#]
Netherlands 1980–2009					
	Consumption of cigarettes	–0.970	–5.097	29	Yes
	Consumption of pipe and hand-rolling tobacco	–0.870	–4.548	29	Yes
Portugal 1970–2009					
	Consumption of cigarettes	–0.311	–2.229	39	Yes
Spain 1960–2009					
	Consumption of cigarettes	–0.546	–4.194	49	Yes
Sweden 1955–2009					
	Consumption of cigarettes	–0.901	–6.635	54	Yes
	Consumption of snus	–0.298	–2.720	54	Yes
United Kingdom 1953–2009					
	Consumption of cigarettes	–0.333	–3.239	56	Yes

ADF = Augmented Dickey-Fuller

Criticical values: 1% = –2.622; 5% = –1.950; 10% = –1.610.

[#] At the significance level of 10%.

As is well known, recursive estimation is a powerful tool that can be used to detect structural changes in models and see how parameter estimates and other model characteristics have changed over time. To get more insight into our estimated models, we have applied recursive estimation techniques that are available in PcGive (Doornik and Hendry 2009). Basically, the idea is to fit the model first to an initial

sample of, say, M observations and then fit it successively to samples of M+1, M+2, … up to the total number of, say, T observations. The results are best illustrated graphically (Appendices F1–F14).[9]

For each of the eleven countries, we analyze tobacco consumption separately by following the estimation strategy outlined above. For each country-specific analysis, we first test all the variables in level form as well as in their first differences for stationarity. Next, we run three models (2)–(4) with variables used in level form and the error correction model (5) with variables used in first differences. For each estimated model, we also carry out several model diagnostic tests. Finally, we use recursive estimation techniques to produce recursive least squares graphical constancy statistics for the estimated error correction model. We use a double log specification for all four models.

[9] For detailed explanations of interpretation, see Doornik and Hendry (2009).

7 Results

7.1 Evaluating and selecting models

The estimation results are reported separately for each country (Tables 8–32). In Table 7, we summarize the results of testing for autocorrelation in residuals for all models conducted for all countries. As noted, testing for autocorrelation in the residuals from a model for time-series data is a central diagnostic tool to evaluate the model. If significant autocorrelation is present in the residuals from an estimated model, this signals that the model is not "dynamically complete", suggesting that further lags should be included in the model as explanatory variables. Typically, additional lags of the dependent variable will be added to the right-hand side of the demand equation. For example, the first lag, the second lag, the third lag, etc. of the consumption variable in first differences $\Delta \ln Q_{st-1}$, $\Delta \ln Q_{st-2}$, $\Delta \ln Q_{st-3}$, ..., can be added to the error correction model of cigarette demand as additional explanatory variables until the estimated model does not exhibit autocorrelation in the residuals.[10]

In this study, we do not pursue the approach of extending the model dynamics described above, but focus on the estimation of four models (2)–(5), i.e., the conventional, partial adjustment, rational addiction, and error correction models. However, augmenting the conventional model (2) with the lagged consumption variable on its right-hand side as an additional explanatory variable—whereby the conventional model (2) becomes the partial adjustment model (3)—is in fact a step of this type. In the event that the conventional model (2) results in strong autocorrelation in the residuals, we would not be surprised if the partial adjustment model (3) results in less autocorrelation in the residuals. That is, compared to model (2), model (3) is much improved in terms of autocorrelation because the residual autocorrelation is less serious in model (3). Models (4) and (5) can be seen as adding further dynamic features to model (3).

Table 7 shows that the conventional model, which is a static model having no lags of any variables on the right-hand side of the equation at all, rarely passes the autocorrelation tests, whereas the more dynamically the model is specified (i.e., the more to the right we move in Table 7), indeed the less often we find autocorrelation in the residuals. Thus, the partial adjustment model passes the autocorrelation tests clearly more often than the conventional model, and the rational addiction model more often than the partial adjustment model. Judging from Table 7, the rational addiction and error correction models perform about equally well on these tests, but

[10] Lagged versions of differenced price and income can also be added to the error correction model (5). Models that use variables in levels, such as the conventional model (2), the partial adjustment model (3), and the rational addiction model (4), can similarly be augmented with lags of consumption, price, income, and other possible explanatory variables. The number of lags can be decided by using t-tests of their significance and other usual model diagnostics, in particular, tests for autocorrelation in residuals.

as we shall see in specific cases, there may be other grounds to choose between these two models.

Table 7. Residual autocorrelation

Country	Conventional model		Partial adjustment model		Rational addiction model		Error correction model	
	Q(1)	AR(2)	Q(1)	AR(2)	Q(1)	AR(2)	Q(1)	AR(2)
Austria	yes	yes	yes	no	yes	no	no	no
Finland								
Cigarettes	yes	yes	no	no	no	no	no	no
Pipe & HRT	yes	yes	yes	yes	yes	no	no	no
France	yes	yes	yes	yes	no	no	no	yes
Germany	yes	yes	yes	no	no	no	no	no
Ireland	yes	yes	yes	no	no	yes	no	no
Italy	yes	yes	yes	yes	yes	no	yes	yes
Netherlands								
Cigarettes	no	no	no	no	no	no	no	no
Pipe & HRT	no	no	no	no	no	no	no	no
Portugal	yes	yes	no	yes	no	no	yes	yes
Spain	yes	yes	yes	yes	yes	no	no	no
Sweden								
Cigarettes	no	no	no	no	yes	no	no	no
Snus	yes	yes	yes	no	yes	no	no	no
United Kingdom	yes	yes	yes	yes	no	no	yes	yes

Note. If not otherwise stated, estimated country-specific models are models of cigarette demand.

Yes (no) = Residual autocorrelation is significant (insignificant) at the significance level of 5%.

HRT = Hand-rolling tobacco

Q(1) = Ljung-Box Q test for serial correlation with one lag included

AR(2) = Breusch-Godfrey Lagrange-multiplier test for autocorrelated residuals with two lags included

If we look carefully at individual t-tests in the fourteen different analyses to be reported, we find a picture that clearly corresponds to that of the residual autocorrelations in Table 7. For example, while the t-statistic for the own price variable is on average −5.47 in the conventional model, it is only −2.10 in the partial adjustment model, which reduces further to −1.44 in the rational addiction model. We observe that for all study countries and tobacco products, when the t-statistic of the own price variable (i.e., the t-statistic of own-price elasticity of demand) is statistically significant, the order of magnitude for the t-statistics resulting from these three models (the conventional model, partial adjustment model, and rational addiction

model) is the same. In addition, in some cases, the coefficient of the own price variable in the conventional model has a very high t-value. For example, for the United Kingdom and Finland, the t-values of the own-price elasticity in the conventional models of cigarette demand are −16.51 and −10.86 respectively. A similar analysis can be done for the t-statistic of the income variable. Furthermore, the simpler models tend to give not only more statistically significant results but also produce higher estimates of the effects of own price and income on consumption (i.e., own-price elasticity and income elasticity).[11] All in all, we should be aware of the danger of a spurious correlation when dealing with time-series data.

It is not always unambiguous for us to decide on our preferred model. Based on the above discussion, we pay particular attention to autocorrelation in the residuals resulting from the different models. In addition, we look at the plausibility of elasticity estimates from the point of view of theoretical expectations and estimated elasticities from previous studies for various countries. In some cases, the "race" between models will be an undecided tie, as they each seem equally good. In other cases, the model choice seems to some extent to be rather arbitrary.

7.2 Austria

Overall, the price variable is not statistically significant in any of the four models and its coefficient estimate is close to zero (Table 8). In addition, income does not statistically affect cigarette consumption in any estimated model (except in the conventional model where the sign of income effect is significantly negative and thus opposite to expectations). In the first three models that use the variables in level form, particularly in the conventional one, autocorrelation in the residuals is exhibited, signalling problems with the model specification for these models.

In the conventional model, the coefficient of the price variable, $\ln P_{st}$, is positive but statistically insignificant (t = 0.22), while the coefficient of the income variable, $\ln Y_t$, is, as noted, negative but statistically significant (t = −4.40) (Table 8). Both results are against expectations. Furthermore, the rather high t-value of the income variable can be seen as a sign of spurious regression, indicating specification error for the conventional model. In both the addiction models, income is insignificantly but negatively related to consumption. In addition, in the partial adjustment model, lagged consumption $\ln Q_{st-1}$ is insignificantly but positively related to current consumption (Table 8). In the rational addiction model, both lagged and lead consumption, $\ln Q_{st-1}$ and $\ln Q_{st+1}$, are positively related to current consumption with the coefficient of lagged consumption (0.616) higher than that of lead consumption (0.298). While the results concerning the effects of lead and lagged consumption on current consumption are all according to our expectations, they indicate that lagged consumption has a larger positive effect on current consumption than does lead

[11] This may also be due to omitted variable bias.

consumption. The coefficient of the tobacco control scale TCS_t is insignificant in the first three models (Table 8).

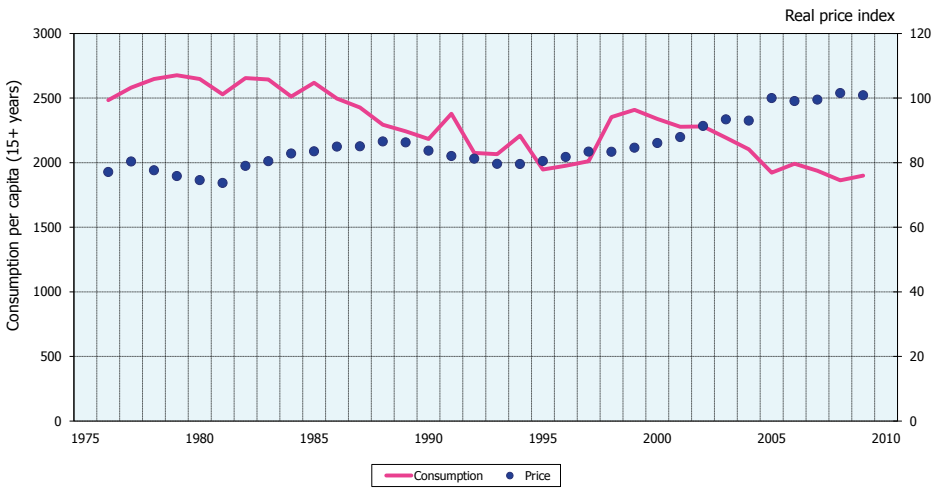

Figure 1. Consumption and real price of cigarettes, Austria 1976–2009

In the error correction model, both the coefficient of the tobacco control scale ΔTCS_t (−0.005) and the adjustment coefficient (−0.477) are statistically significant and also negative, as expected. Hence, the error correction model reverts to equilibrium. Tobacco control policies described by the tobacco control scale ΔTCS_t negatively affect cigarette consumption: a 10-point increase in the tobacco control policy index 0–100 would reduce per capita cigarette consumption by 5%. Comparing estimation and diagnostic test results from all four estimated models shows that the error correction model does not exhibit autocorrelation in residuals denoted by the test results Ljung-Box Q(1) (p = 0.600) and AR(2) (p = 0.597) (see Tables 7–8). Therefore, we prefer the error correction model regardless of its positive price elasticity (i.e., the coefficient of the price variable $\Delta \ln P_{st}$ 0.039). While the positive effect of price on consumption is against our expectation, this effect is not statistically significant. Neither does the estimated income elasticity obtained from this model (i.e., the coefficient of the income variable $\Delta \ln Y_t$), 0.235, deviate significantly from zero.

The recursive estimation graphs based on the error correction model, particularly the one-step residuals and one-up Chow tests (i.e., graphs 'Res1Step' and '1upCHOWs'), show that this model does not manage to accommodate the large increase in consumption in 1998 represented by the peaks in both those graphs (Appendix F1). The reason for the increase in consumption in 1998 should be further explored. Are there changes in the way the statistics are kept or/and in cross-border trade in 1997–1998?

Table 8. Estimation results from the demand models for cigarettes, Austria 1976–2009

Variable	Conventional model		Partial adjustment[a] model		Rational addiction[b] model		Error correction model	
	Coeff.	*t*	Coeff.	*t*	Coeff.	*t*	Coeff.	*t*
Constant	14.057	8.84	12.30	0.93	1.450	0.16	-0.003	-0.26
TCS_t	-0.002	-1.03	-0.001	-0.22	0.000	0.03		
lnP_{st}	0.058	0.22	-0.014	-0.04	-0.071	-0.25		
lnY_t	-0.664	-4.40	-0.623	-0.83	-0.048	-0.10		
lnQ_{st-1}			0.214	0.23	0.616	1.74		
lnQ_{st+1}					0.298	0.54		
ΔTCS_t							-0.005	-2.03
ΔlnP_{st}							0.039	0.11
ΔlnY_t							0.235	0.45
Adjustment coefficient							-0.477	-3.25
Model	F(3, 30) = 26.53		F(4, 27) = 22.97		F(5, 24) = 18.80		F(4, 28) = 3.81	
Adjusted R^2	0.699		0.752		0.775		0.260	
Root MSE	0.063		0.057		0.051		0.049	
Number of observations	34		32		30		33	
Test	Statistic	*p*-value	Statistic	*p*-value	Statistic	*p*-value	Statistic	*p*-value
Ljung-Box Q(1)	9.706	0.003	3.917	0.048	6.500	0.011	0.275	0.600
AR(2)	9.128	0.010	0.308	0.857	3.628	0.163	1.032	0.597
Normality	0.974	0.592	0.986	0.944	0.973	0.576	0.983	0.866
Heteroscedasticity[c]	21.495	0.011	26.259	0.024	11.067	0.352	5.882	0.969
RESET	3.520	0.028					1.080	0.378

[a] The instruments consist of two lag prices of cigarettes plus the other explanatory variables in the model.

[b] The instruments consist of two lead prices and two lag prices of cigarettes plus the other explanatory variables in the model.

[c] Heteroscedasticity test is the White test for heteroscedasticity using squares and cross products. For the rational addiction model, the White test for heteroscedasticity only uses squares of the explanatory variables.

Ljung-Box Q(1) = Ljung-Box Q test for serial correlation with one lag included.

AR(2) = Breusch-Godfrey Lagrange-multiplier test for autocorrelated residuals with two lags included.

Normality test is the Shapiro-Wilk test for normal residuals.

We tentatively conclude that cigarette consumption in Austria seems to respond to the implemented tobacco control policies but not to changes in real cigarette price and real disposable income. Table 9 summarizes the elasticity estimates of demand for cigarettes obtained from all the four different models for Austria, although not all of the models are acceptable and not all of the estimates are statistically significant.

Short-run price elasticities of demand for cigarettes previously reported for Austria using aggregate data over 10–31 years in the period 1950–1994 and different econometric models vary between about –0.95 (Koutsoyannis 1963), –0.83 (Escario and Molina 2001), –0.54 (Wörgötter and Kunze 1986),[12] and –0.34 (Stewart 1993). Of these, only one study displayed an income elasticity of demand of 0.11 (Koutsoyannis 1963).

Table 9. Elasticity estimates of demand for cigarettes, Austria 1976–2009

Model	Price elasticity		Income elasticity
	Short run	Long run	
Conventional model	0.058		-0.664
Partial adjustment model	-0.014	-0.018	-0.623
Rational addiction model	-0.071	-0.828	-0.048
Error correction model	0.039	0.058	0.235

7.3 Finland

For Finland, two tobacco products for which demand is studied are cigarettes and pipe and hand-rolling tobacco. Figure 2 presents per capita annual consumption and the real price of cigarettes consumed in Finland in 1960–2009.

For cigarettes, the estimation results with the signs, magnitudes and t-values of the coefficients as well as the residual autocorrelation tests from the last three demand models generally seem to be reasonable (Table 10). Regarding the conventional model, this exhibits significant autocorrelation in the residuals and obviously some spurious relations. These spurious correlations are addressed most notably by the high short-run price elasticity estimate −0.851 (i.e., the coefficient of the price variable $\ln P_{st}$) and its high t-value −10.86. Both the t-values become smaller in the partial adjustment model, in which lagged consumption $\ln Q_{st-1}$ is added as an explanatory variable, and are even lower in the rational addiction model, which has lagged $\ln Q_{st-1}$ and lead consumption $\ln Q_{st+1}$ as explanatory variables. In both addiction models, lagged consumption $\ln Q_{st-1}$ is statistically significant and positively related to current consumption. In addition, in the rational addiction model, lead consumption $\ln Q_{st+1}$ is positively related to current consumption. Furthermore, the significant coefficient estimate of lagged consumption (0.513) is higher than that of the lead consumption (0.265), which is quite near to significant. These findings are in accordance with our hypotheses, suggesting that past consumption positively influences current consumption more than future consumption, while cigarette consumption is rationally addictive.

[12] Cited in Andrews and Franke (1991).

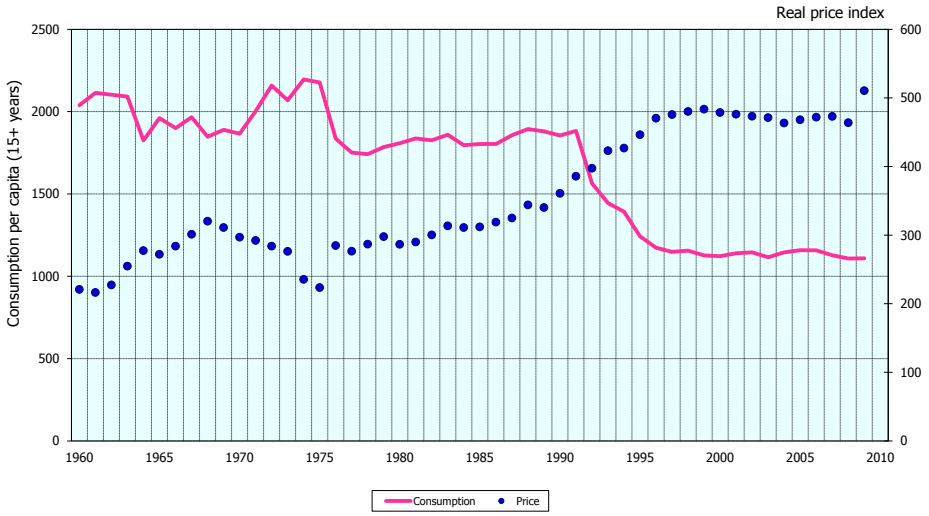

Figure 2. Consumption and real price of cigarettes, Finland 1960–2009

In the last three demand models for cigarettes, estimated short-run price elasticities of demand for cigarettes vary between −0.22 and −0.41, while short-run income elasticities vary between 0.09 and 0.36 (Table 10). Of these models, the error correction model provides the highest short-run price elasticity and income elasticity.

In the conventional model for cigarettes, the role of the tobacco control scale TCS_t is clearly exaggerated as displayed by both the size of the effect of TCS_t (−0.006) and its highly significant t-value (−5.54) (Table 10). In the last three models, the coefficients of the tobacco control scale variable (i.e., the coefficient of TCS_t in both the addiction models and the coefficient of ΔTCS_t in the error correction model) are all negative, as we expected, and are not so far from being significant, with t-values of −1.73, −1.28, and −1.56 respectively. In addition, the coefficient of D1964 and that of ΔD1964 are significantly negative. These findings imply that the health scare in 1964 had a decreasing effect on cigarette consumption. Moreover, as expected the estimated adjustment coefficient in the error correction model is negative.

Figure 3 shows how per capita consumption and real price of pipe and hand-rolling tobacco have varied in Finland over the period 1960–2002.[13] For consumption of pipe and hand-rolling tobacco, it is less straightforward to interpret results obtained from the estimated models. As seen, all the first three models show first order autocorrelation in the residuals (Table 11). However, the error correction model does not exhibit residual autocorrelation as described by two test results (Ljung-Box Q(1) p = 0.758; AR(2) p = 0.622) (Table 11), which we prefer.

[13] Data on consumption of pipe and hand-rolling tobacco have not been available since 2003.

Table 10. Estimation results from the demand models for cigarettes, Finland 1960–2009

Variable	Conventional model		Partial adjustment[a] model		Rational addiction[b] model		Error correction model	
	Coeff.	*t*	Coeff.	*t*	Coeff.	*t*	Coeff.	*t*
Constant	8.613	11.54	3.769	3.01	2.109	1.56	-0.011	-1.08
D1964	-0.034	-0.48	-0.103	-2.13	-0.101	-2.56		
D1992	0.074	1.81	-0.027	-0.78	-0.012	-0.39		
TCS_t	-0.006	-5.54	-0.002	-1.73	-0.001	-1.28		
lnP_{st}	-0.851	-10.86	-0.357	-3.04	-0.220	-1.80		
lnY_t	0.423	4.94	0.131	1.65	0.092	1.34		
lnQ_{st-1}			0.615	4.83	0.513	4.17		
lnQ_{st+1}					0.265	1.72		
ΔD1964							-0.081	-2.64
ΔD1992							-0.003	-0.10
ΔTCS_t							-0.002	-1.56
ΔlnP_{st}							-0.413	-3.33
ΔlnY_t							0.358	1.53
Adjustment coefficient							-0.153	-1.43
Model	F(5, 44) = 118.53		F(6, 41) = 221.21		F(7, 38) = 255.86		F(6, 42) = 6.15	
Adjusted R^2	0.923		0.969		0.976		0.392	
Root MSE	0.067		0.044		0.036		0.042	
Number of observations	50		48		46		49	
Test	Statistic	*p*-value	Statistic	*p*-value	Statistic	*p*-value	Statistic	*p*-value
Ljung-Box Q(1)	21.290	0.000	3.777	0.052	0.917	0.338	0.024	0.877
AR(2)	23.127	0.000	3.651	0.161	1.104	0.576	0.069	0.966
Normality	0.986	0.808	0.951	0.041	0.956	0.067	0.950	0.036
Heterosce-dasticity	32.587	0.000	23.883	0.067	40.685	0.006	41.495	0.001
RESET	30.730	0.000					6.900	0.001

[a] The instruments consist of two lag prices of cigarettes plus the other explanatory variables in the model.

[b] The instruments consist of two lead prices and two lag prices of cigarettes plus the other explanatory variables in the model.

Ljung-Box Q(1) = Ljung-Box Q test for serial correlation with one lag included.

AR(2) = Breusch-Godfrey Lagrange-multiplier test for autocorrelated residuals with two lags included.

Normality test is the Shapiro-Wilk test for normal residuals.

Heteroscedasticity test is the White test for heteroscedasticity using squares and cross products.

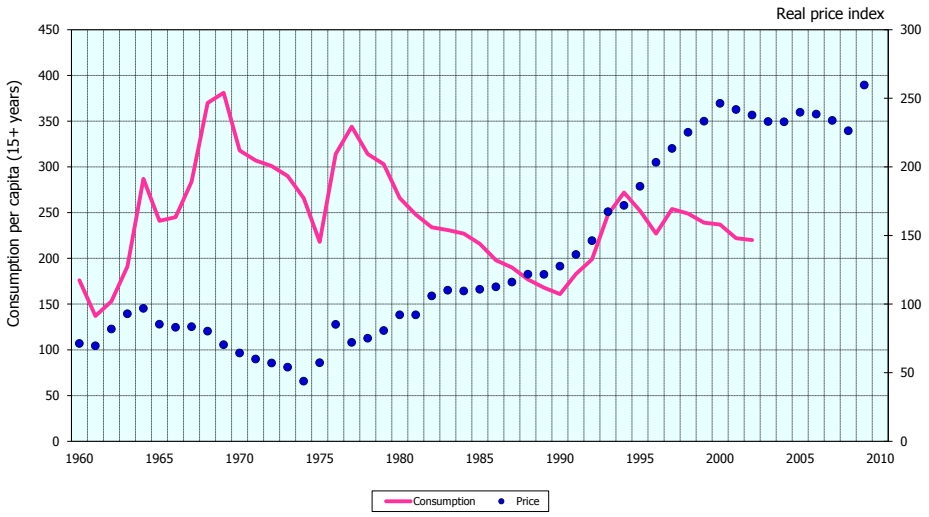

Figure 3. Consumption (g) and real price of pipe and hand-rolling tobacco, Finland 1960–2002

According to the error correction model of demand for pipe and hand-rolling tobacco, the estimated short-run own-price elasticity (i.e., the coefficient of price of pipe and hand-rolling tobacco $\Delta \ln P_{pt}$) is −0.43, while the cross-price elasticity (i.e., the coefficient of cigarette price $\Delta \ln P_{st}$) is 1.73 (Table 11). A 10% increase in the real price of pipe and hand-rolling tobacco tends to decrease its own demand by 4.3%, while a similar increase in the real price of cigarettes tends to increase the demand for pipe and hand-rolling tobacco by 17.3%. The latter result suggests that when real cigarette price rises, cigarette consumers tend to switch from cigarettes to pipe and hand-rolling tobacco. That is, pipe and hand-rolling tobacco appears to be a substitute for cigarettes. Demand for pipe and hand-rolling tobacco is more responsive to a given percentage change in the price of cigarettes than to the same percentage change in its own price, which has been observed earlier (Pekurinen 1989, 1992).

In the error correction model of the demand for pipe and hand-rolling tobacco, perhaps surprisingly, the effect of the tobacco control scale variable ΔTCS_t on consumption is positive and the effect of real income $\Delta \ln Y_t$ on consumption is negative (Table 11). In other words, enhanced tobacco control policies encourage per capita consumption of this tobacco product, but higher real disposable income per capita reduces its consumption. Both these effects are opposite to the results obtained from the models of cigarette demand.

Table 11. Estimation results from the demand models for pipe and hand-rolling tobacco, Finland 1960–2002

Variable	Conventional model		Partial adjustment[a] model		Rational addiction[b] model		Error correction model	
	Coeff.	*t*	Coeff.	*t*	Coeff.	*t*	Coeff.	*t*
Constant	5.136	3.24	8.499	1.45	7.039	1.14	0.012	0.54
D1964	0.326	2.15	0.223	1.32	0.300	1.40		
D1992	-0.059	-0.67	-0.075	-0.40	-0.258	-1.12		
TCS_t	0.010	3.30	0.013	1.13	0.019	1.48		
lnP_{pt}	-1.163	-8.22	-1.225	-1.23	-1.615	-1.50		
lnP_{st}	2.285	8.40	2.341	1.38	2.742	1.53		
lnY_t	-0.836	-4.20	-1.111	-1.54	-1.061	-1.41		
lnQ_{pt-1}			-0.167	-0.20	-0.772	-0.82		
lnQ_{pt+1}					0.664	2.09		
ΔD1964							0.245	4.03
ΔD1992							-0.000	-0.01
ΔTCS_t							0.004	1.07
ΔlnP_{pt}							-0.426	-2.47
ΔlnP_{st}							1.733	5.40
ΔlnY_t							-1.257	-2.61
Adjustment coefficient							-0.187	-1.52
Model	F(6, 36) = 13.57		F(7, 33) = 8.97		F(8, 30) = 5.36		F(7, 34) = 11.85	
Adjusted R^2	0.642		0.546		0.300		0.650	
Root MSE	0.141		0.148		0.187		0.083	
Number of observations	43		41		39		42	
Test	Statistic	*p*-value	Statistic	*p*-value	Statistic	*p*-value	Statistic	*p*-value
Ljung-Box Q(1)	41.951	0.002	43.318	0.001	9.675	0.002	0.095	0.758
AR(2)	19.907	0.000	7.260	0.027	2.961	0.228	0.949	0.622
Normality	0.935	0.018	0.944	0.041	0.986	0.888	0.949	0.059
Heteroscedasticity[c]	28.341	0.020	37.092	0.016	35.260	0.162	10.686	0.711
RESET	0.220	0.883					3.630	0.023

[a] The instruments consist of two lag prices of pipe and hand-rolling tobacco plus the other explanatory variables in the model.

[b] The instruments consist of two lead prices and two lag prices of pipe and hand-rolling tobacco plus the other explanatory variables in the model.

[c] For the error correction model, the White test for heteroscedasticity only uses squares of the explanatory variables.

Ljung-Box Q(1) = Ljung-Box Q test for serial correlation with one lag included.

AR(2) = Breusch-Godfrey Lagrange-multiplier test for autocorrelated residuals with two lags included.

Normality test is the Shapiro-Wilk test for normal residuals.

Heteroscedasticity test is the White test for heteroscedasticity using squares and cross products.

There may be several explanations for the positive effect of tobacco control policies and the negative effect of real income on the consumption of pipe and hand-rolling tobacco. Compared to cigarette consumption, pipe and hand-rolling tobacco is typically used in other circumstances and places as well as among people with distinctive socio-demographic and socio-economic characteristics, such as higher age. Although implemented tobacco control policies have been directed against all forms of tobacco, in effect they affect cigarette consumers to a greater extent than users of other forms of tobacco, including pipe and hand-rolling tobacco. Perhaps, when tobacco control policies are strengthened, they affect cigarette smokers more effectively so that they actually reduce cigarette smoking, but at the same time making cigarette consumers switch from cigarettes to pipe and hand-rolling tobacco. On the other hand, the negative short-run income elasticity seems to indicate that pipe and hand-rolling tobacco is an inferior product, i.e., consumers of pipe and hand-rolling tobacco with higher income would prefer cigarettes to cheaper tobacco. In addition, based on results from many international demand studies, those who currently use pipe and hand-rolling tobacco or have switched from expensive cigarettes to cheaper pipe and hand-rolling tobacco are relatively poorer or in lower income groups (Chaloupka and Warner 2000).

In the error correction model of demand for pipe and hand-rolling tobacco, the direction of the effect of the 1964 health scare (ΔD1964) on consumption is positive and statistically significant (Table 11). This increasing effect is clearly against our hypothesis and also opposite to the significantly decreasing effect of the same variable in the models for cigarettes. We can argue that while D1964 or ΔD1964 in the models of cigarettes is measuring the actual effect of the intervention (health scare) on cigarette consumption, perhaps the same explanatory variable in the models of pipe and hand-rolling tobacco also captures part of the effect of cigarette price changes on consumption of cheap tobacco (Pekurinen 1989, 1992). Alternatively, it is possible that the 1964 health scare increased the use of pipe and hand-rolling tobacco because this form of tobacco, like cigars, were less implicated in the epidemiological studies published than cigarettes.

Elasticity estimates of demand for both tobacco products for Finland are summarized in Table 12. In summary, in the case of Finland, we prefer to base conclusions on the addiction models or on the error correction models for cigarettes, but for pipe and hand-rolling tobacco we base conclusions on only the error correction model. All these four estimated models passed two residual autocorrelation tests (see Tables 7 and 10–11). The short-run own-price elasticity estimates of demand for cigarettes vary between −0.22 and −0.41, while it is −0.43 for pipe and hand-rolling tobacco. The estimated long-run price elasticity is around −0.9 (more precisely, they vary between −0.85 and −0.99) for cigarettes and −1.2 for pipe and hand-rolling tobacco. The cross-price elasticity of demand for pipe and hand-rolling tobacco is estimated to be 1.73. Income elasticities are estimated to be 0.09–0.36 for cigarettes and −1.26 for pipe and hand-rolling tobacco.

Table 12. Elasticity estimates of demand for tobacco products, Finland 1960–2009

Model	Cigarettes 1960–2009			Pipe and hand-rolling tobacco 1960–2002			
	Own-price elasticity		Income elasticity	Own-price elasticity		Cross-price elasticity	Income elasticity
	Short run	Long run		Short run	Long run		
Conventional model	-0.851		0.423	-1.163		2.285	-0.836
Partial adjustment model	-0.357	-0.929	0.131	-1.225	-1.050	2.341	-1.111
Rational addiction model	-0.220	-0.991	0.092	-1.615	-1.458	2.742	-1.061
Error correction model	-0.413	-0.851	0.358	-0.426	-1.163	1.733	-1.257

Previous studies utilizing Finnish aggregate data and different econometric models over 10–40 years between 1950 and 1999 show that for cigarettes, the short-run price elasticity estimates of demand fall within the range −0.16 to −0.71 with a median of −0.43 and the income elasticities vary between 0.02 and 1.24 with a median of 0.37 (Koutsoyannis 1963; Valtonen 1992;[14] Pekurinen 1989, 1992; Stewart 1993; Punkari and Pekurinen 1996; Salo and Pekurinen 1996; Salomaa 1998; Escario and Molina 2001; Leppänen 2001), whereas the long-run price elasticities are −0.77 and −0.85 (Salo and Pekurinen 1996). For pipe and hand-rolling tobacco, the short-run own-price elasticity estimates of demand previously obtained vary between −0.03 and −0.60 with a median of −0.36, whereas the cross-price elasticity estimates of demand with respect to cigarette price vary between 1.50 and 2.36 with a median of 1.86 (Valtonen 1982;[15] Pekurinen 1989, 1992; Punkari and Pekurinen 1996; Salomaa 1998; Leppänen 2001).

Of the recursive estimation graphs for Finland, the one-step residuals 'Res1Step' and one-up Chow '1up CHOWs' -tests show that the error correction model does not manage to accommodate the change in cigarette consumption in 1995 (Appendix F2), nor the change in consumption of pipe and hand-rolling tobacco in 1988 nor that in 1996 (Appendix F3). Furthermore, as seen in Figure 2, the effect of the economic depression from 1992–1994 on cigarette consumption seems rather permanent. Perhaps, the depression captured by the dummy variable D1992 should alternatively be defined as describing a permanent effect. This is a topic for further research.

[14] Studies cited in Valtonen (1982) were Sehm (1976), Rimpelä et al. (1976), and Sehm (1979).
[15] Studies cited in Valtonen (1982) were Rimpelä et al. (1976) and Sehm (1979).

7.4 France

Among the four estimated models of cigarette demand for France, only the rational addiction model does not exhibit significant residual autocorrelation (Table 13). The error correction model still displays this autocorrelation problem somewhat, as shown by the second test result AR(2) (p = 0.030), whereas the conventional and partial adjustment models do not cope well in any of the two residual autocorrelation tests (p = 0.000 for both tests). Significant residual autocorrelation in these two models implies model specification error.

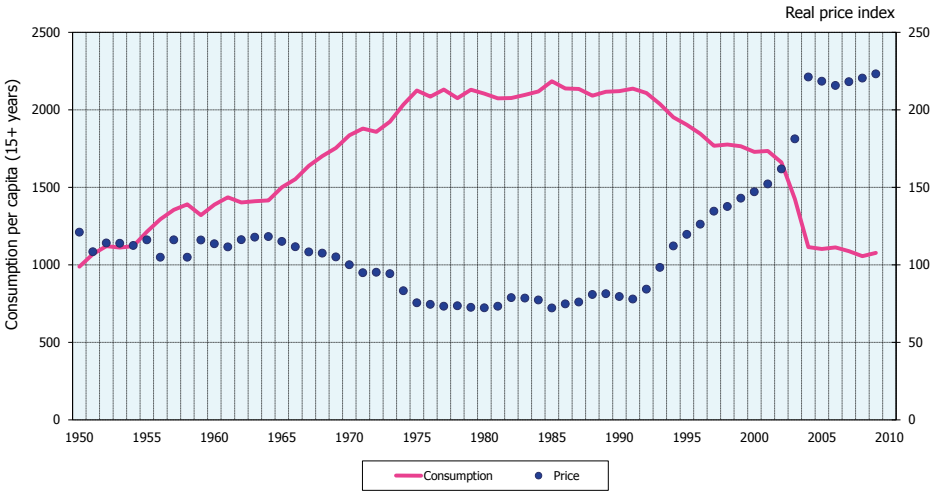

Figure 4. Consumption of cigarettes and real price of tobacco, France 1950–2009

In the conventional model, the coefficients of the tobacco control scale TCS_t, price lnP_{st} and income lnY_t have expected signs, but their t-values are remarkably high (Table 13). In particular, the high t-value of income (t = 13.08) in this model signals a spurious relation. Indeed, in the partial adjustment model, lagged consumption lnQ_{st-1} is significantly and positively related to current consumption. As is clear, when moving from the conventional model to the partial adjustment one, both the coefficient estimates of all explanatory variables other than the lagged consumption variable lnQ_{st-1} and their t-values decrease considerably. In the rational addiction model, both lagged and lead consumption, lnQ_{st-1} and lnQ_{st+1}, are significantly and positively associated with current consumption. The positive directions of both effects on cigarette consumption are in concordance with our hypotheses. Furthermore, the coefficient of the lagged consumption variable lnQ_{st-1} (0.489) is larger than that of the lead consumption variable lnQ_{st+1} (0.438), which was also expected. However, besides the significant lagged and lead consumption variables, no other variables are statistically significant in the rational addiction model.

Table 13. Estimation results from the demand models for cigarettes, France 1950–2009

Variable	Conventional model		Partial adjustment[a] model		Rational addiction[b] model		Error correction model	
	Coeff.	*t*	Coeff.	*t*	Coeff.	*t*	Coeff.	*t*
Constant	4.494	7.48	3.304	4.50	0.708	0.68	-0.004	-0.54
TCS_t	-0.006	-4.53	-0.003	-2.75	0.000	0.20		
lnP_{st}	-0.384	-6.07	-0.272	-4.02	-0.067	-0.81		
lnY_t	0.499	13.08	0.285	3.48	0.015	0.16		
lnQ_{st-1}			0.364	2.55	0.489	6.43		
lnQ_{st+1}					0.438	2.04		
ΔTCS_t							-0.002	-1.82
ΔlnP_{st}							-0.499	-6.54
ΔlnY_t							0.513	2.75
Adjustment coefficient							-0.075	-1.05
Model	F(3, 56) = 262.26		F(4, 53) = 342.54		F(5, 50) = 779.92		F(4, 54) = 21.26	
Adjusted R^2	0.930		0.961		0.987		0.583	
Root MSE	0.066		0.047		0.026		0.033	
Number of observations	60		58		56		59	
Test	Statistic	*p*-value	Statistic	*p*-value	Statistic	*p*-value	Statistic	*p*-value
Ljung-Box Q(1)	44.216	0.000	32.341	0.000	0.322	0.570	2.120	0.145
AR(2)	45.063	0.000	22.809	0.000	2.706	0.259	7.014	0.030
Normality	0.974	0.234	0.969	0.130	0.892	0.000	0.883	0.000
Heterosce-dasticity	46.485	0.000	43.545	0.000	53.667	0.000	43.463	0.000
RESET	71.130	0.000					9.070	0.000

[a] The instruments consist of two lag prices of cigarettes plus the other explanatory variables in the model.

[b] The instruments consist of two lead prices and two lag prices of cigarettes plus the other explanatory variables in the model.

Ljung-Box Q(1) = Ljung-Box Q test for serial correlation with one lag included.

AR(2) = Breusch-Godfrey Lagrange-multiplier test for autocorrelated residuals with two lags included.

Normality test is the Shapiro-Wilk test for normal residuals.

Heteroscedasticity test is the White test for heteroscedasticity using squares and cross products.

In the error correction model, all coefficients of the explanatory variables have the expected signs (Table 13). That is, cigarette consumption is significantly and negatively affected by price (ΔlnP_{st}) and by implemented tobacco control interventions, as indicated by the tobacco control scale (ΔTCS_t), but significantly and positively affected by income (ΔlnY_t). In addition, the adjustment coefficient estimate is insignificantly negative. The short-run price and income elasticity estimates are –0.50

and 0.51 respectively (Table 13). These suggest that cigarette consumption reduces by 0.5% for every 1% increase in its real price and increases also by about 0.5% for every 1% increase in real household disposable income. The coefficient of the ΔTCS_t variable −0.002 implies that cigarette consumption will reduce by about 2% for every 10-point increase in the tobacco control policy index 0–100 (Table 13). Hence, it seems that higher prices and enhanced tobacco control policies have been able to reduce cigarette consumption effectively in France.

Table 14. Elasticity estimates of demand for cigarettes, France 1950–2009

Model	Price elasticity		Income elasticity
	Short run	Long run	
Conventional model	-0.384		0.499
Partial adjustment model	-0.272	-0.427	0.285
Rational addiction model	-0.067	-0.913	0.015
Error correction model	-0.499	-0.384	0.513

Table 14 summarizes our elasticity estimates of demand for cigarettes for France. Among the four estimated models of cigarette demand, our preferred model is a choice between the rational addiction model and the error correction model, which is not unequivocal at this stage. The rational addiction model passed both autocorrelation tests Q(1) and AR(2) ($p = 0.570$ and $p = 0.259$), but it produces price and income elasticity estimates which are perhaps implausible low (Table 13). Further, it uses all the time-series variables of interest that are non-stationary I(1) processes (Appendix D3). In contrast, the error correction model did not pass the second autocorrelation test AR(2) ($p = 0.030$) (Table 13), but it uses the time-series variables in first differences that are stationary I(0) processes (Appendix D3). For this reason, we would perhaps give preference to the error correction model over the rational addiction model. However, because the estimated error correction model still shows signs of autocorrelation, the model possibly requires dynamic extension. Including further lags of the dependent variable, e.g. at least one lagged consumption in first difference, $\Delta \ln Q_{t-1}$, as an additional explanatory variable to the error correction model should be tested out on the basis of the residual autocorrelation in this model.

Based on the rational addiction and error correction models, the estimated short-run price elasticities of cigarette demand vary between −0.07 and −0.50, the long-run price elasticities between −0.38 and −0.91, and the income elasticities between 0.02 and 0.51 (Table 14). Price elasticity estimates of cigarette demand reported in previous studies for France over 10–31 years in the period 1950–1994 are −0.23 (Koutsoyannis 1963) and −0.54 (Stewart 1993).

The recursive estimation results based on the error correction model for cigarettes indicate that this model did not accommodate the large reduction in consumption in

the beginning of the 2000s (Appendix F4, see especially graphs 'Res1Step', '1upCHOWs', and 'Ndn CHOWs'). The large negative residual for 2004 implies that the observed consumption that year decreased considerably more than predicted by the model at the time (Appendix F4, see the downwards peak in graph 'Res1Step'). That is, the model did not immediately manage to cope with the dramatic fall in annual consumption (22%) in 2004 following a sharp increase in annual price (also 22%) in the same year, which can be seen from Figure 4. Nevertheless, we can only speculate as to whether and to what extent the decrease in consumption in 2004 represents e.g. smuggling. However, the model very soon adjusts itself to this change in consumption. For example, the price elasticity estimates obtained from the error correction model, in absolute terms, double in 2004 and stay stable until the end of the study period (Appendix F4, see graph 'DLptob × +/−SE' where Dlptob stands for $\Delta \ln P_{st}$ and SE standard errors).

7.5 Germany

Of four estimated models of cigarette demand for Germany, the rational addiction and error correction models seem to satisfy all model specification tests conducted (Table 15). The error correction model seem to manage better than the rational addiction model because all its test results received higher p-values than the corresponding test results for the rational addiction model (Table 15). Residual autocorrelation is somewhat exhibited in the partial adjustment model, while it is significantly shown in the conventional model. Although the conventional model produces coefficient estimates having the signs that we expected, the price elasticity (i.e., the coefficient of the price variable $\ln P_{st}$) is very high in its absolute value (−1.10) and so is its t-value (−8.26). As noted earlier, high t-values are typical symptoms of spurious regression, especially in combination with significant autocorrelation in the residuals.

In both the partial adjustment and rational addiction models, the coefficient of the lagged consumption variable $\ln Q_{st-1}$ is significantly positive as expected (Table 15). In addition, in the rational addiction model, the coefficient of the lead consumption variable $\ln Q_{st+1}$ is also positive (0.184) and smaller than that of the lagged consumption variable $\ln Q_{st-1}$ (0.292). Hence, past consumption has a larger impact on current consumption than future consumption. All these results for lagged and lead consumption correspond with our theoretical assumptions. Moreover, compared to the estimation results obtained from the partial adjustment model, when both lagged and lead consumption variables, $\ln Q_{st-1}$ and $\ln Q_{st+1}$, are included as explanatory variables in the rational addiction model, both the coefficients of the other explanatory variables and their t-values, in absolute terms, become smaller (Table 15). However, in the rational addiction model, only the negative price elasticity (i.e., the coefficient of the price variable $\ln P_{st}$) is statistically significant. Nevertheless, the autocorrelation in residuals, which is quite significant in the conventional model, decreases when both lagged and lead consumption variables appear as explanatory variables in the rational addiction model. In the error correction model, all esti-

mated coefficients of explanatory variables other than the tobacco control scale ΔTCS_t are statistically significant, and the directions of their effects on consumption correspond with our expectations (Table 15). The coefficient of the tobacco control scale ΔTCS_t is positive but not statistically significant (t = 0.40).

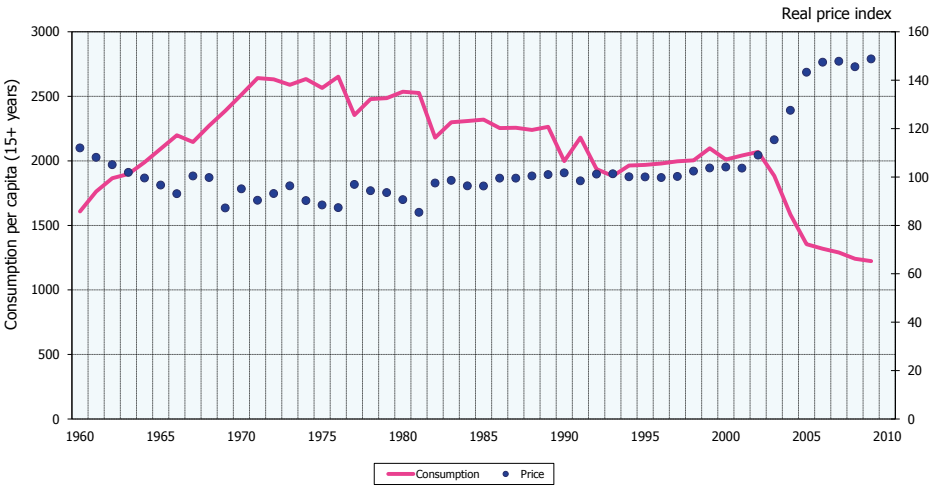

Figure 5. Consumption and real price of cigarettes, Germany 1960–2009

As neither the rational addiction model nor the error correction model exhibit significant residual autocorrelation, we prefer these two models (Table 15) with a slightly higher preference for the error correction model due to its clearly less degree of autocorrelation. In this comparison of models, a further argument against the rational addiction model is that we cannot reject the null hypothesis that the coefficient of the lead consumption variable $\ln Q_{st+1}$ in this model is different from zero. Rejecting the rational addiction model would lead us to the partial adjustment model, which suffers from autocorrelation in the residuals.

Table 16 summarizes elasticity estimates of demand for cigarettes for Germany. The short-run price elasticity and income elasticity provided by the rational addiction model are −0.67 and 0.09, while those analogous estimates provided by the error correction model are −0.79 and 0.69 (Table 16). That is, cigarette consumption reduces by about 0.7–0.8% for every 1% increase in its real price and decreases by about 0.1–0.7% for every 1% increase in household disposable income. Price elasticity estimates of demand that have been produced earlier using time-series data are −0.54 for West Germany (Stewart 1993) and −0.42 for the whole country (Escario and Molina 2001). The income elasticity estimates obtained from previous studies for West Germany are −0.01 and 0.50 (Reuijl 1982; Leeflang and Reuijl 1985)[16].

[16] Cited in Andrews and Franke (1991).

Table 15. Estimation results from the demand models for cigarettes, Germany 1960–2009

Variable	Conventional model		Partial adjustment[a] model		Rational addiction[b] model		Error correction model	
	Coeff.	*t*	Coeff.	*t*	Coeff.	*t*	Coeff.	*t*
Constant	10.412	10.13	8.216	5.42	6.289	3.34	-0.013	-2.12
TCS_t	-0.005	-2.67	-0.002	-1.23	-0.002	-0.64		
lnP_{st}	-1.098	-8.26	-0.841	-5.11	-0.672	-3.61		
lnY_t	0.245	4.33	0.100	1.23	0.087	1.10		
lnQ_{st-1}			0.312	1.83	0.292	1.94		
lnQ_{st+1}					0.184	1.16		
ΔTCS_t							0.001	0.40
ΔlnP_{st}							-0.788	-7.24
ΔlnY_t							0.688	4.70
Adjustment coefficient							-0.358	-3.82
Model	F(3, 46) = 191.70		F(4, 43) = 209.78		F(5, 40) = 138.63		F(4, 44) = 25.51	
Adjusted R^2	0.921		0.948		0.941		0.671	
Root MSE	0.057		0.046		0.042		0.036	
Number of observations	50		48		46		49	
Test	Statistic	*p*-value	Statistic	*p*-value	Statistic	*p*-value	Statistic	*p*-value
Ljung-Box Q(1)	21.834	0.000	6.957	0.008	1.218	0.270	0.000	0.989
AR(2)	21.742	0.000	3.546	0.170	4.475	0.107	0.318	0.853
Normality	0.980	0.536	0.975	0.391	0.954	0.059	0.983	0.689
Heteroscedasticity	15.358	0.082	16.274	0.297	20.243	0.027	7.027	0.934
RESET	1.410	0.252					1.790	0.165

[a] The instruments consist of two lag prices of cigarettes plus the other explanatory variables in the model.

[b] The instruments consist of two lead prices and two lag prices of cigarettes plus the other explanatory variables in the model.

Ljung-Box Q(1) = Ljung-Box Q test for serial correlation with one lag included.

AR(2) = Breusch-Godfrey Lagrange-multiplier test for autocorrelated residuals with two lags included.

Normality test is the Shapiro-Wilk test for normal residuals.

Heteroscedasticity test is the White test for heteroscedasticity using squares and cross products.

The short-run price elasticity estimates –0.67 and –0.79 obtained from our two preferred models seem to be rather high (Table 16). An explanation for the high effect of cigarette price on cigarette consumption would be the observed dramatic increase in smoking in the former East part of Germany after the 1990 reunification with its social liberalization and democracy (Forey et al. 2011). Given the nature of aggregate data used in this study, we only can argue that higher cigarette prices have negative

impacts on cigarette consumption, which is particularly effective in youth, women, and lower income groups or disadvantaged social classes (Chaloupka and Warner 2000; Wilson and Thomson 2005; Jha 2009).

Table 16. Elasticity estimates of demand for cigarettes, Germany 1960–2009

Model	Price elasticity		Income elasticity
	Short run	Long run	
Conventional model	-1.098		0.245
Partial adjustment model	-0.841	-1.222	0.100
Rational addiction model	-0.672	-1.284	0.087
Error correction model	-0.788	-1.098	0.688

The recursive estimation figures based on the error correction model of cigarette demand for Germany show that significant structural changes occurred in the 1970s and in the beginning of the 1990s (see Appendix F5, graphs 'Res1Step', '1upCHOWs', 'Ndn CHOWs'). Also, as seen from the graph 'DLy × +/–2SE', at the end of the 1970s income became insignificant for a few years. The structural changes that happened in the beginning of the 1990s were perhaps caused by the reunification of Germany in 1990 and the accompanying data problems. The estimated error correction does not seem to accommodate the large consumption reduction of 11.2% in 1992 as compared to consumption in 1991. This is shown by the downwards peak in the graph 'Res1Step' and the upwards peak in the graph '1upCHOWs', which are outside the 95% confidence bounds in 1992.

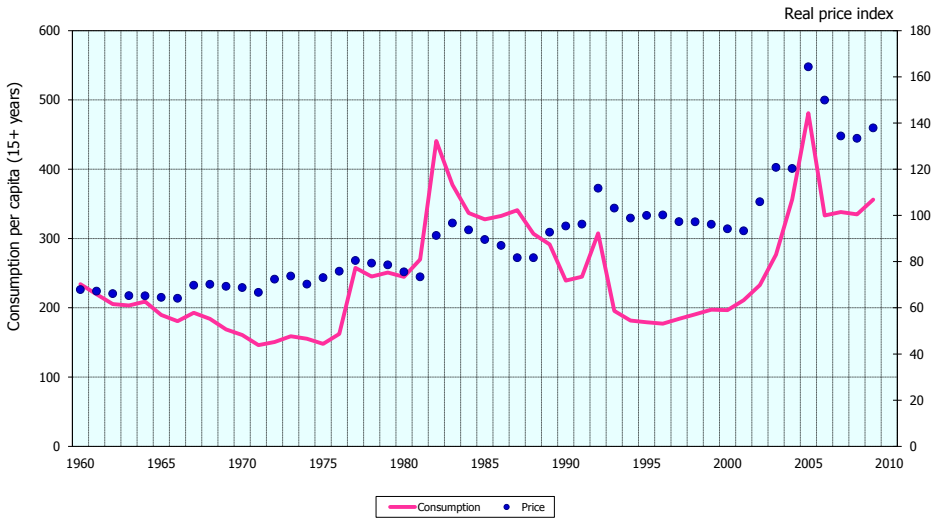

Figure 6. Consumption (g) and real price of pipe and hand-rolling tobacco, Germany 1960–2009

We do not present estimation results from the models of demand for pipe and hand-rolling tobacco for Germany. As seen in Figure 6, the time series of consumption exhibits sharp peaks in 1982, 1992 and 2005. More work is needed with model specification to get a reasonably fit to the data for pipe and hand-rolling tobacco consumed in Germany.

7.6 Ireland

For cigarettes consumed in Ireland, both the conventional and partial adjustment models produce negative income elasticity estimates, which are against our expectations (Table 17). However, these estimates are not statistically significant. The estimated short-run price elasticity is positive in the partial adjustment model, while negative in the conventional and rational addiction models, as expected, although the price elasticity estimates obtained from the latter model are insignificant.

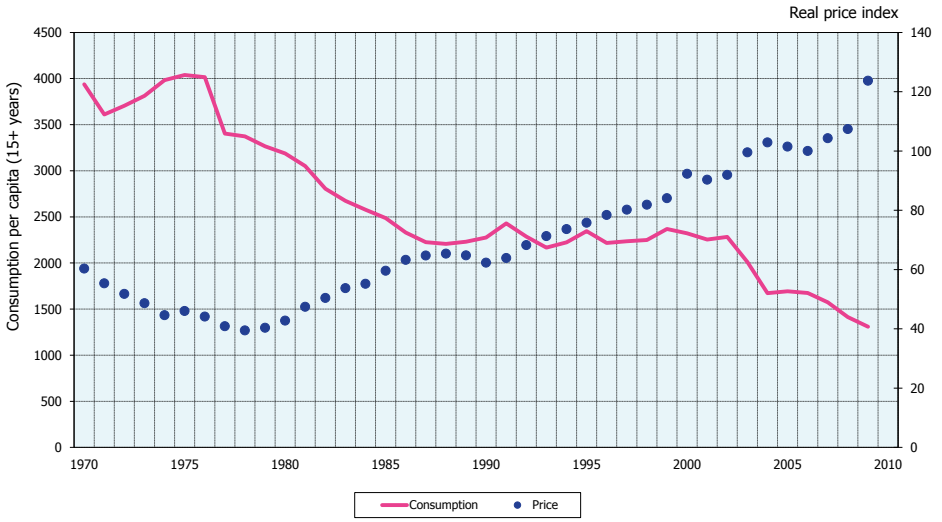

Figure 7. Consumption and real price of cigarettes, Ireland 1970–2009

Lagged consumption $\ln Q_{st-1}$ has a significantly positive effect on current consumption in both the partial adjustment and the rational addiction models, and lead consumption $\ln Q_{st+1}$ also has a significantly increasing effect on current consumption in the latter model (Table 17). All the first three models show significant autocorrelation in the residuals that decreases when lagged consumption $\ln Q_{st-1}$ is included in the partial adjustment model and both lagged and lead consumption $\ln Q_{st-1}$ and $\ln Q_{st+1}$ are introduced into the rational addiction model as explanatory variables (Table 17).

Table 17. Estimation results from the demand models for cigarettes, Ireland 1970–2009

Variable	Conventional model		Partial adjustment[a] model		Rational addiction[b] model		Error correction model	
	Coeff.	*t*	Coeff.	*t*	Coeff.	*t*	Coeff.	*t*
Constant	11.257	7.60	-7.560	-1.28	-0.499	-0.57	-0.025	-2.29
TCS_t	-0.002	-1.33	0.001	0.48	-0.000	-0.72		
lnP_{st}	-0.590	-4.15	0.845	1.34	-0.032	-0.38		
lnY_t	-0.094	-0.51	-0.325	-1.01	0.072	0.99		
lnQ_{st-1}			1.909	2.73	0.434	2.88		
lnQ_{st+1}					0.560	4.23		
ΔTCS_t							-0.003	-2.74
ΔlnP_{st}							-0.265	-1.46
ΔlnY_t							0.398	1.61
Adjustment coefficient							-0.109	-1.50
Model	F(3, 36) = 49.07		F(4, 33) = 44.75		F(5, 30) = 287.83		F(4, 34) = 4.37	
Adjusted R^2	0.787		0.817		0.978		0.262	
Root MSE	0.136		0.122		0.038		0.049	
Number of observations	40		38		36		39	
Test	Statistic	*p*-value	Statistic	*p*-value	Statistic	*p*-value	Statistic	*p*-value
Ljung-Box Q(1)	30.020	0.000	7.032	0.008	3.357	0.067	0.433	0.510
AR(2)	30.591	0.000	3.124	0.210	14.410	0.001	1.416	0.493
Normality	0.938	0.029	0.946	0.059	0.972	0.439	0.945	0.056
Heterosce-dasticity	31.440	0.000	29.387	0.009	31.333	0.051	14.614	0.405
RESET	13.300	0.000					1.790	0.170

[a] The instruments consist of two lag prices of cigarettes plus the other explanatory variables in the model.

[b] The instruments consist of two lead prices and two lag prices of cigarettes plus the other explanatory variables in the model.

Ljung-Box Q(1) = Ljung-Box Q test for serial correlation with one lag included.

AR(2) = Breusch-Godfrey Lagrange-multiplier test for autocorrelated residuals with two lags included.

Normality test is the Shapiro-Wilk test for normal residuals.

Heteroscedasticity test is the White test for heteroscedasticity using squares and cross products.

Among four estimated models of cigarette demand for Ireland, only the error correction model passed both of the residual correlation tests (Table 17). Therefore, we prefer to draw our conclusions mainly on the basis of the error correction model. In this model, while each estimated coefficient has the expected sign, that of the tobacco control scale variable ΔTCS_t (–0.003) is the only statistically significant one. However, the other estimated coefficients are not far from significance, with their t-va-

lues in absolute terms around 1.46–1.61 (Table 17). The coefficient of ΔTCS_t –0.003 implies that a 10-point increase in the tobacco control policy index 0–100 reduces cigarette consumption by 3%. The estimated short-run price elasticity is –0.27 and the estimated short-run income elasticity is 0.40. These estimates suggest that cigarette consumption decreases by about 2.7% for every 10% increase in its real cigarette price and increases by 4% for every 10% increase in real household disposable income.

Elasticity estimates of demand for cigarettes for Ireland are summarized in Table 18. Several previous studies have used aggregate data over 14–31 years to study the effect of cigarette price on cigarette demand in Ireland. They have shown short-run price elasticity estimates that vary between –0.29 and –0.99 (O'Riordan 1969; Walsh 1980; Stewart 1993; Madden 1993; Conniffe 1995; Cornelsen and Normand 2011), while a much higher estimate has also been reported (Escario and Molina 2001). The long-run price elasticity estimates reported are clustered around –0.39.

Table 18. Elasticity estimates of demand for cigarettes, Ireland 1970–2009

Model	Price elasticity		Income elasticity
	Short run	Long run	
Conventional model	-0.590		-0.094
Partial adjustment model	0.845	0.930	-0.325
Rational addiction model	-0.032	-5.356	0.072
Error correction model	-0.265	-0.590	0.398

The recursive estimation results based on the error correction model show rather stable structures (Appendix F6). However, it seems that the increase in cigarette consumption in 1991 is not well accommodated by the model at that point (Appendix F6, see graph '1upCHOWs'). Furthermore, the tobacco control scale variable ΔTCS_t only became statistically significant with the expectedly right sign since the beginning of the 2000s (Appendix F6, see graph 'Dtcs × +/–2SE'). This detection is in accordance with the fact that the tobacco control policy index considerably increased in 2004 as compared to the previous year because Ireland strengthened tobacco control interventions in 2004 and the tobacco control policy index has not changed much from 2004 onwards (see Table 4 and Appendix E6).

7.7 Italy

There are some diagnostic problems with the fit of the first three models for Italy's cigarette consumption (Table 19). In particular, the residuals in these models exhibit autocorrelation. In addition, the high t-value of the price variable $\ln P_{st}$ in the conventional model (−6.38) can be seen as a sign of spurious regression. Further, in both the partial adjustment and rational addiction models, the coefficients of the tobacco control scale and income variables, TCS_t and $\ln Y_t$, as well as that of lagged consumption $\ln Q_{t-1}$ have opposite signs to what we expected (i.e., current consumption is positively related to implemented tobacco control policies TCS_t and negatively related to income $\ln Y_t$ and to past consumption $\ln Q_{t-1}$) although they are all statistically insignificant. Moreover, in the rational addiction model, lead consumption $\ln Q_{t+1}$ is statistically insignificant but positively associated with current consumption (Table 19).

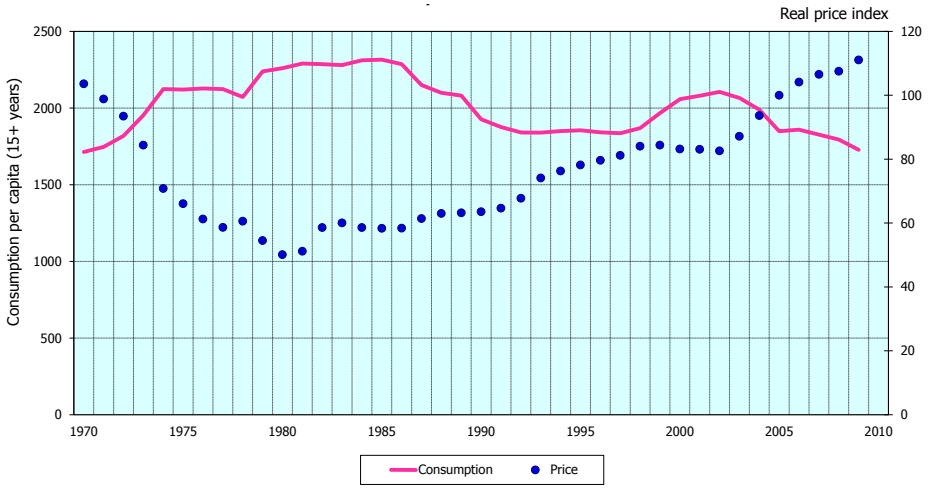

Figure 8. Consumption of cigarettes and real price of tobacco, Italy 1970–2009

Taking into consideration all estimation results obtained from the four models, we prefer the error correction model for Italy, despite autocorrelation in its residuals. This model provides parameter estimates that have the expected directions of their effects on consumption (Table 19). Accordingly, the short-run price elasticity of cigarette demand is −0.373 and income elasticity 0.098, although the latter result is statistically insignificant. The coefficient of the tobacco control scale variable ΔTCS_t and the adjustment coefficient are negative as expected, but their t-values are not statistically significant.

Our elasticity estimates of demand for cigarettes for Italy are summarized in Table 20. Previous studies using aggregate data and a variety of econometric models to explore short-run price elasticity estimates of cigarette demand for Italy over 6–43 years have shown estimates between –0.09 and –0.88 with a median of –0.41 (Kout-

soyannis 1963; Stewart 1993; Escario and Molina 2001; Tiezzi 2005;[17] Gallus et al. 2003; Pierani and Tiezzi 2009). The long-run price elasticities that have been previously estimated vary between –0.31 and –1.96 with a median of –0.75 (Tiezzi 2005;[18] Pierani and Tiezzi 2009). However, only one income elasticity estimate is available, which is 0.10 (Gallus et al. 2003).

Table 19. Estimation results from the demand models for cigarettes, Italy 1970–2009

Variable	Conventional model		Partial adjustment[a] model		Rational addiction[b] model		Error correction model	
	Coeff.	*t*	Coeff.	*t*	Coeff.	*t*	Coeff.	*t*
Constant	9.962	7.63	12.581	1.20	6.379	1.01	0.000	0.05
TCS_t	0.001	0.97	0.002	0.55	0.002	0.79		
lnP_{st}	-0.372	-6.38	-0.439	-1.05	-0.246	-1.12		
lnY_t	-0.081	-0.67	-0.138	-0.66	-0.090	-0.61		
lnQ_{st-1}			-0.235	-0.25	-0.017	-0.04		
lnQ_{st+1}					0.428	1.19		
ΔTCS_t							-0.000	-0.43
ΔlnP_{st}							-0.373	-4.35
ΔlnY_t							0.098	0.56
Adjustment coefficient							-0.108	-1.26
Model	F(3, 36) = 23.06		F(4, 33) = 9.16		F(5, 30) = 17.56		F(4, 34) = 7.25	
Adjusted R^2	0.629		0.379		0.772		0.397	
Root MSE	0.056		0.069		0.040		0.027	
Number of observations	40		38		36		39	
Test	Statistic	*p*-value	Statistic	*p*-value	Statistic	*p*-value	Statistic	*p*-value
Ljung-Box Q(1)	31.080	0.000	31.288	0.000	19.403	0.000	7.744	0.005
AR(2)	31.445	0.000	13.206	0.001	1.447	0.485	10.274	0.006
Normality	0.970	0.355	0.971	0.406	0.978	0.637	0.970	0.380
Heterosce-dasticity	19.103	0.024	34.116	0.002	32.149	0.042	7.618	0.908
RESET	6.270	0.002					0.940	0.433

[a] The instruments consist of two lag prices of cigarettes plus the other explanatory variables in the model.

[b] The instruments consist of two lead prices and two lag prices of cigarettes plus the other explanatory variables in the model.

Ljung-Box Q(1) = Ljung-Box Q test for serial correlation with one lag included.

AR(2) = Breusch-Godfrey Lagrange-multiplier test for autocorrelated residuals with two lags included.

Normality test is the Shapiro-Wilk test for normal residuals.

Heteroscedasticity test is the White test for heteroscedasticity using squares and cross products.

[17] Tiezzi (2005) cited Rizzi and Balli (2002).

[18] Tiezzi (2005) cited studies: Caiumi (1992), Jones and Giannoni Mazzi (1996), Rizzi (2000), and Rizzi and Balli (2002).

Table 20. Elasticity estimates of demand for cigarettes, Italy 1970–2009

Model	Price elasticity		Income elasticity
	Short run	Long run	
Conventional model	-0.372		-0.081
Partial adjustment model	-0.439	-0.355	-0.138
Rational addiction model	-0.246	-0.418	-0.090
Error correction model	-0.373	-0.372	0.098

The diagnostic test results show that the error correction model exhibits significant residual autocorrelation as shown by two test results (Table 19, Ljung-Box Q(1) p = 0.005 and AR(2) p = 0.006). This indicates that perhaps further lags of the consumption variable in first differences such as $\Delta \ln Q_{st-1}$, $\Delta \ln Q_{st-2}$, $\Delta \ln Q_{st-3}$, ..., should be added in the error correction model as additional explanatory variables until it displays no significant residual autocorrelation (Table 19).

The recursive estimation results based on the error correction model show some instability (Appendix F7). Specifically, the decrease in consumption in 1990 is not well accommodated by the model at the time (shown by the downwards peak in the graph 'Res1Step' and the upwards peak in the graph '1up CHOWs'). In addition, according to the 'Nup CHOWs' test, there was a significant structural break in the beginning of the 1980s and in the beginning of the 1990s. The consumption reduction in 1990 probably related to cigarette smuggling in Italy. It has been estimated that in Italy, legal cigarette consumption decreased in the period 1985–1990 when cigarette smuggling increased (Gallus et al. 2003) and cigarette smuggling accounted for some 15% of consumption in the 1990s (Joossens et al. 2009). In this analysis, we are not able to account for the effects of cross-border or illicit trade on legal trade within the country (i.e. official legal sale in the study) due to lack of reliable information on smuggling and other cross-border trade and due to the long study period. However, it is clear that legal trade is affected when illicit or/and cross-border trade exist. Hence, price elasticity estimates of cigarette demand that are obtained using official sale data without taking into account illicit and cross-border trade will be higher in absolute value. In other words, it is likely that we would obtain lower price elasticity estimates of demand in absolute values if consumption data would have included illicit and cross-border trade.

It is also of interest to observe that the coefficient of the tobacco control scale variable ΔTCS_t was positive until 2004 and slightly near to zero but negative from 2005 onwards (Appendix F7, see graph 'Dtcs × +/–2SE'). This is in line with the tobacco control policy index increasing by 21.9 point in 2005 as compared to the previous year, with Italy having enhanced tobacco control interventions in 2005. After this year and in the absence of any new interventions, the policy index has remained unchanged (see Table 4 and Appendix E7).

7.8 Netherlands

For the Netherlands, two tobacco products for which demand is studied are cigarettes and pipe and hand-rolling tobacco. Figure 9 shows how cigarette consumption and the real price index have varied and Figure 10 how consumption of pipe and hand-rolling tobacco and its real price index have varied in the Netherlands over the period 1980–2009.

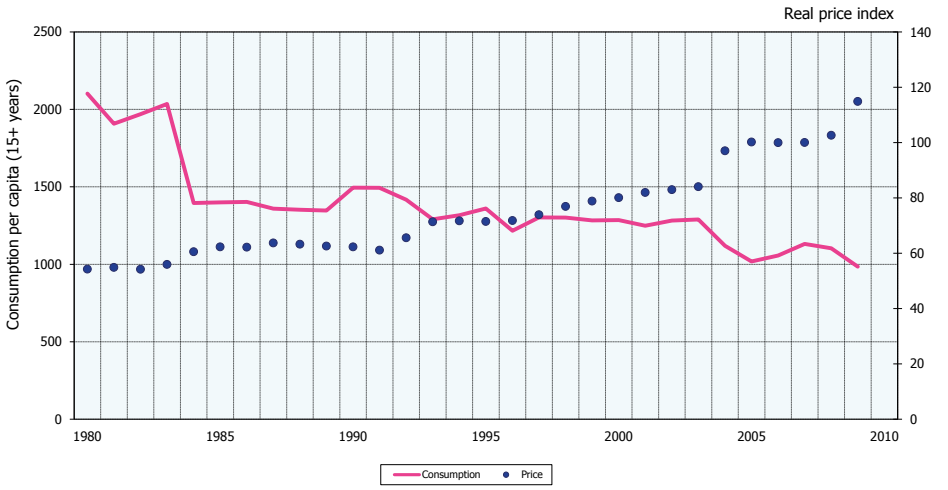

Figure 9. Consumption and real price of cigarettes, Netherlands 1980–2009

It is not easy to understand the estimation results for the Netherlands and to figure out what's behind them. For example, in the first three models the own-price elasticity estimates of demand for cigarettes are very high: −1.95 in the conventional model, −1.84 in the partial adjustment model and even higher (−3.10) in the rational addiction model (Table 21). In addition, the t-value of the own price variable $\ln P_{st}$ in the conventional model is high at −9.00. Since the high t-values are generally an indication of possible spurious relation, one would expect to find autocorrelation in residuals in the estimated model (as described above). Nevertheless, in this case none of these models exhibit significant autocorrelation in the residuals as described by the reported test results for autocorrelation: Ljung-Box Q(1) and Breusch-Godfrey Lagrange-multiplier test AR(2) (Table 21).

In all the models for cigarettes, while each coefficient of the tobacco control scale variable (TCS_t or ΔTCS_t) is either significant or quite near to significant, the tobacco control scale variable itself is positively related to cigarette consumption, which is clearly against our expectation (Table 21). On the other hand, although the estimated income elasticities (i.e., the coefficients of the income variable $\ln Y_t$ or

$\Delta \ln Y_t$) are not statistically significant in any of the models for cigarettes, income is positively associated with cigarette consumption, being concordant with our expectation.

Table 21. Estimation results from the demand models for cigarettes, Netherlands 1980–2009

Variable	Conventional model		Partial adjustment[a] model		Rational addiction[b] model		Error correction model	
	Coeff.	*t*	Coeff.	*t*	Coeff.	*t*	Coeff.	*t*
Constant	11.790	5.41	10.343	2.42	16.397	1.63	-0.014	-1.30
TCS_t	0.005	2.12	0.004	1.79	0.004	1.55		
$\ln P_{st}$	-1.954	-9.00	-1.840	-3.92	-3.100	-1.92		
$\ln P_{pt}$	0.631	3.78	0.602	1.99	1.181	1.45		
$\ln Y_t$	0.104	0.46	0.145	0.56	0.338	1.01		
$\ln Q_{st-1}$			0.095	0.43	-0.084	-0.22		
$\ln Q_{st+1}$					-0.515	-0.86		
ΔTCS_t							0.004	2.49
$\Delta \ln P_{st}$							-0.635	-2.02
$\Delta \ln P_{pt}$							-0.451	-2.23
$\Delta \ln Y_t$							0.214	0.66
Adjustment coefficient							-1.049	-7.31
Model	F(4, 25) = 61.86		F(5, 22) = 31.10		F(6, 19) = 15.32		F(5, 23) = 21.83	
Adjusted R^2	0.894		0.849		0.768		0.788	
Root MSE	0.062		0.062		0.073		0.041	
Number of observations	30		28		26		29	
Test	Statistic	*p*-value	Statistic	*p*-value	Statistic	*p*-value	Statistic	*p*-value
Ljung-Box Q(1)	0.030	0.864	0.170	0.680	2.751	0.097	2.596	0.107
AR(2)	0.216	0.898	0.040	0.980	1.047	0.592	6.442	0.040
Normality	0.822	0.000	0.842	0.001	0.915	0.027	0.937	0.083
Heteroscedasticity[c]	19.816	0.136	13.589	0.193	15.199	0.231	9.563	0.480
RESET	1.780	0.180					1.520	0.241

[a] The instruments consist of two lag prices of cigarettes plus the other explanatory variables in the model.

[b] The instruments consist of two lead prices and two lag prices of cigarettes plus the other explanatory variables in the model.

[c] For the conventional model, the White test for heteroscedasticity uses squares and cross products. For the three other models, the White test for heteroscedasticity only uses squares of the explanatory variables.

Ljung-Box Q(1) = Ljung-Box Q test for serial correlation with one lag included.

AR(2) = Breusch-Godfrey Lagrange-multiplier test for autocorrelated residuals with two lags included.

Normality test is the Shapiro-Wilk test for normal residuals.

In the first three models for cigarettes, all the coefficients of the price of pipe and hand-rolling tobacco $\ln P_{pt}$ are positive (Table 21). These positive cross-price elasticity estimates suggest that cigarettes are a substitute for pipe and hand-rolling tobacco. However, in the error correction model of cigarette demand, the coefficient of the price of pipe and hand-rolling tobacco $\Delta \ln P_{pt}$ is negative (−0.451), which is against our expectation and not in concordance with cigarettes acting as a substitute for pipe and hand-rolling tobacco.

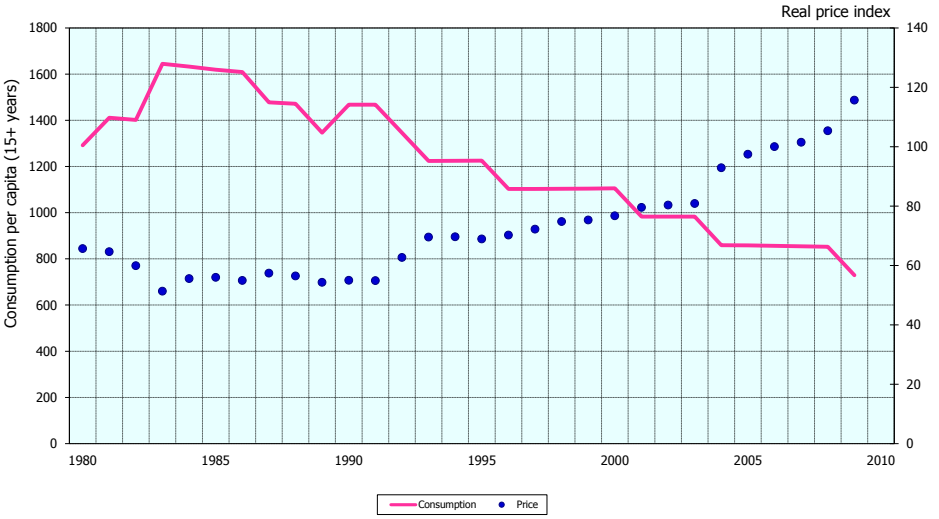

Figure 10. Consumption (g) and real price of pipe and hand-rolling tobacco, Netherlands 1980–2009

Regarding the models estimated for pipe and hand-rolling tobacco, the coefficients of the tobacco control scale variable TCS_t in the first three models and that of ΔTCS_t in the error correction model are basically zero and statistically insignificant (Table 22). While income is positively, although insignificantly, related to cigarette consumption in all models for cigarettes, income is negatively related to consumption of pipe and hand-rolling tobacco in all models for this product. This finding may suggest that those who smoke pipe and hand-rolling tobacco could switch to cigarettes when their real income increases and/or they are relatively poorer or in lower income categories than cigarette smokers (Chaloupka and Warner 2000). On the other hand, in all models for pipe and hand-rolling tobacco, the own-price elasticity of demand (i.e., the coefficient of the price variable of pipe and hand-rolling tobacco $\ln P_{pt}$ or $\Delta \ln P_{pt}$) is statistically significant and negative as expected.

Table 22. Estimation results from the demand models for pipe and hand-rolling tobacco, Netherlands 1980–2009

Variable	Conventional model		Partial adjustment[a] model		Rational addiction[b] model		Error correction model	
	Coeff.	*t*	Coeff.	*t*	Coeff.	*t*	Coeff.	*t*
Constant	15.472	10.64	14.197	4.64	14.309	2.42	0.007	0.65
TCS_t	-0.000	-0.26	0.000	0.01	-0.000	-0.15		
lnP_{st}	-0.734	-6.60	-0.717	-3.27	-0.681	-2.92		
lnP_{pt}	0.005	0.04	0.005	0.02	0.036	0.13		
lnY_t	-0.544	-3.66	-0.485	-2.57	-0.534	-1.82		
lnQ_{st-1}			0.087	0.43	0.163	0.81		
lnQ_{st+1}					-0.064	-0.23		
ΔTCS_t							-0.001	-0.61
ΔlnP_{st}							-0.551	-2.67
ΔlnP_{pt}							-0.272	-0.87
ΔlnY_t							-0.690	-2.06
Adjustment coefficient							-0.939	-4.00
Model	F(4, 25) = 228.89		F(5, 22) = 169.99		F(6, 19) = 106.04		F(5, 23) = 10.56	
Adjusted R^2	0.969		0.969		0.962		0.631	
Root MSE	0.041		0.042		0.043		0.041	
Number of observations	30		28		26		29	
Test	Statistic	*p*-value	Statistic	*p*-value	Statistic	*p*-value	Statistic	*p*-value
Ljung-Box Q(1)	0.501	0.479	0.342	0.559	0.769	0.381	0.168	0.682
AR(2)	0.910	0.634	0.675	0.714	0.915	0.633	3.044	0.218
Normality	0.959	0.293	0.946	0.140	0.925	0.047	0.957	0.274
Heteroscedasticity[c]	22.223	0.074	11.049	0.354	14.800	0.253	16.088	0.097
RESET	0.210	0.887					2.990	0.056

[a] The instruments consist of two lag prices of pipe and hand-rolling tobacco plus the other explanatory variables in the model.

[b] The instruments consist of two lead prices and two lag prices of pipe and pipe and hand-rolling tobacco plus the other explanatory variables in the model.

[c] For the conventional model, the White test for heteroscedasticity uses squares and cross products. For the three other models, the White test for heteroscedasticity only uses squares of the explanatory variables.

Ljung-Box Q(1) = Ljung-Box Q test for serial correlation with one lag included.

AR(2) = Breusch-Godfrey Lagrange-multiplier test for autocorrelated residuals with two lags included.

Normality test is the Shapiro-Wilk test for normal residuals.

The recursive estimation graphs based on the error correction models of demand for both tobacco products seem to be fine (Appendices F8 and F9). However, for cigarette consumption, there is a downwards peak in the 'Res1Step' graph and an upwards peak in the '1upCHOWs' graph in 1996 that clearly oversteps the confidence bounds of 95% (Appendix F8). Furthermore, we have tested multicollinearity of the variables and found that it is present particularly for the tobacco control scale variable and the price variables. As this can affect our estimation results, the estimated models for the Netherlands need to be further investigated, tested and developed, especially in respect to the effect of multicollinearity. In this situation, caution is needed in interpreting the results. In particular, we suspect that the effects brought about by the price variables and the tobacco control scale variable are mixed due to the correlations between those two variable types.

Table 23. Elasticity estimates of demand for tobacco products, Netherlands 1980–2009

Model	Cigarettes				Pipe and hand-rolling tobacco			
	Own-price elasticity		Cross-price elasticity	Income elasticity	Own-price elasticity		Cross-price elasticity	Income elasticity
	Short run	Long run			Short run	Long run		
Conventional model	-1.954		0.631	0.104	-0.734		0.005	-0.544
Partial adjustment model	-1.840	-2.034	0.602	0.145	-0.717	-0.785	0.005	-0.485
Rational addiction model	-3.100	-1.939	1.181	0.338	-0.681	-0.756	0.036	-0.534
Error correction model	-0.635	-1.954	-0.451	0.214	-0.551	-0.734	-0.272	-0.690

Elasticity estimates obtained for the Netherlands are summarized in Table 23. We abstain at this stage from selecting preferred models. However, we note that the short-run own-price elasticity of demand for cigarettes provided by the error correction model is –0.635 and that the short-run price elasticities of demand for pipe and hand-rolling tobacco range from –0.551 to –0.734 depending on the different models. The estimated income elasticity is positive for cigarettes; for example, 0.21 is derived from the error correction model and is negative for pipe and hand-rolling tobacco as discussed above.

Previous studies that used aggregate data over 27–31 years have shown price elasticity estimates of cigarette demand of –0.69 (Stewart 1993) and –0.75 (Escario and Molina 2001). Mindell and Whynes (2000) estimated that the price elasticity of demand for manufactured cigarettes was –0.74 during 1970–1980 and –0.54 during 1985–1995. In addition, in 1985–1995 consumption of manufactured cigarettes decreased by 0.6% for every 1% increase in the difference between the price of manufactured cigarettes and

the price of hand-rolled cigarettes (i.e., elasticity was –0.60). Also in the same period, consumption of hand-rolled cigarettes increased by 1.03% for every 1% increase in the ratio of the price of manufactured cigarettes to the price of hand-rolled cigarettes (i.e., elasticity was 1.03). The income elasticity estimate of demand for manufactured cigarettes was 0.91, and the corresponding estimates for hand-rolled cigarettes were 1.70 (for 1970–1980) and –1.60 (for 1985–1995) (Mindell and Whynes 2000).

7.9 Portugal

For Portugal, we see a sharp decrease in cigarette consumption from 2006 to 2007 (31%) and a continued reduction in consumption in the period 2007–2009 (Figure 11). This seems to be a response to increases in real cigarette prices. However, during that period the annual percentage reduction in cigarette consumption was many times higher than the annual percentage increase in real cigarette prices.

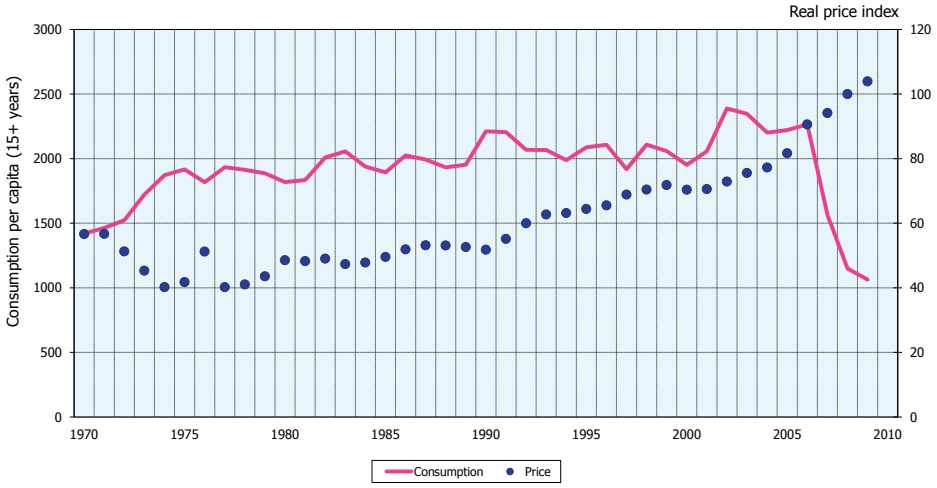

Figure 11. Consumption of cigarettes and real price of tobacco, Portugal 1970–2009

Regarding the estimation results from the models, the short-run price elasticity (i.e., the coefficient of the price variable $\ln P_{st}$ or $\Delta \ln P_{st}$) is indeed negative and statistically significant in the conventional, partial adjustment, and error correction models (Table 24). Among the four estimated models, the conventional and error correction models suffer from autocorrelation in the residuals (Ljung-Box Q(1) p = 0.000 and 0.048; AR(2) p = 0.000 and 0.020) more than the other two models (Ljung-Box Q(1) p = 0.344 and 0.297; AR(2) p = 0.018 and 0.097). Consequently, the price and income elasticities (i.e., the coefficients of the price variable $\ln P_{st}$ and the income variable $\ln Y_t$) seem exaggerated in the conventional model, both in the magnitude of the

estimated coefficients and in their t-values (t = −4.45 for the price elasticity and t = 4.90 for the income elasticity) (Table 24).

Table 24. Estimation results from the demand models for cigarettes, Portugal 1970–2009

Variable	Conventional model		Partial adjustment[a] model		Rational addiction[b] model		Error correction model	
	Coeff.	*t*	Coeff.	*t*	Coeff.	*t*	Coeff.	*t*
Constant	1.691	1.02	-1.265	-0.98	0.929	0.38	0.006	0.39
TCS_t	0.001	0.36	-0.001	-0.46	0.001	0.60		
lnP_{st}	-0.869	-4.45	-0.442	-2.55	-0.288	-1.13		
lnY_t	0.997	4.90	0.467	2.55	0.252	1.04		
lnQ_{st-1}			0.826	4.06	0.593	2.46		
lnQ_{st+1}					0.123	0.40		
ΔTCS_t							-0.004	-1.30
ΔlnP_{st}							-0.427	-2.07
ΔlnY_t							0.106	0.28
Adjustment coefficient							-0.243	-1.86
Model	F(3, 36) = 10.08		F(4, 33) = 18.14		F(5, 30) = 8.07		F(4, 34) = 2.91	
Adjusted R^2	0.411		0.755		0.552		0.167	
Root MSE	0.131		0.081		0.065		0.089	
Number of observations	40		38		36		39	
Test	Statistic	*p*-value	Statistic	*p*-value	Statistic	*p*-value	Statistic	*p*-value
Ljung-Box Q(1)	13.822	0.000	0.895	0.344	1.088	0.297	3.904	0.048
AR(2)	21.130	0.000	8.012	0.018	4.666	0.097	7.846	0.020
Normality	0.964	0.234	0.960	0.174	0.856	0.000	0.886	0.001
Heterosce-dasticity	30.782	0.000	30.110	0.007	32.267	0.041	29.910	0.008
RESET	4.890	0.006					1.320	0.285

[a] The instruments consist of two lag prices of cigarettes plus the other explanatory variables in the model.

[b] The instruments consist of two lead prices and two lag prices of cigarettes plus the other explanatory variables in the model.

Ljung-Box Q(1) = Ljung-Box Q test for serial correlation with one lag included.

AR(2) = Breusch-Godfrey Lagrange-multiplier test for autocorrelated residuals with two lags included.

Normality test is the Shapiro-Wilk test for normal residuals.

Heteroscedasticity test is the White test for heteroscedasticity using squares and cross products.

When lagged consumption lnQ_{st-1} appears in the partial adjustment model as an explanatory variable, both the price and income elasticity estimates and their t-values become smaller (Table 24). Moving from the partial adjustment model to the rational addiction one, in which both lagged and lead consumption lnQ_{st-1} and lnQ_{st+1}

appear as explanatory variables, both the price and income elasticity estimates and their t-values diminish further. In both these addiction models, lagged consumption $\ln Q_{st-1}$ is statistically and positively related to current consumption (coefficients 0.826 and 0.593; t-values 4.06 and 2.46), which is in concordance with our expectation. However, although in the rational addiction model the coefficient of lead consumption variable $\ln Q_{st+1}$ (0.123) is positive and smaller than that of the lagged consumption variable $\ln Q_{st-1}$ (0.593) as expected, the effect of lead consumption $\ln Q_{st+1}$ on current consumption is not statistically significant (t = 0.40). On the other hand, while the coefficient estimate of the tobacco control scale TCS_t is close to zero (0.001, −0.001, and 0.001) and statistically insignificant (t-values 0.36, −0.46, and 0.60) in the first three models, that of the tobacco control scale ΔTCS_t is negative (−0.004), as expected, and less insignificant (t = −1.30) in the error correction model. In this model, the estimated price elasticity (i.e., the coefficient of $\Delta \ln P_t$) is −0.43 and statistically significant, while the estimated income elasticity (i.e., the coefficient of $\Delta \ln Y_t$) is 0.11 and statistically insignificant (t = 0.28). Moreover, as expected the adjustment coefficient is negative and statistically significant.

Table 25. Elasticity estimates of demand for cigarettes, Portugal 1970–2009

Model	Price elasticity		Income elasticity
	Short run	Long run	
Conventional model	-0.869		0.997
Partial adjustment model	-0.442	-2.540	0.467
Rational addiction model	-0.288	-1.016	0.252
Error correction model	-0.427	-0.869	0.106

Elasticity estimates of demand for cigarettes for Portugal are summarized in Table 25. We prefer the three other models over the conventional model, but do not have a single preferred model among these three. The conventional model highly exhibits autocorrelation in the residuals as shown by the two autocorrelation test results (Tables 24). While the partial adjustment and error correction models still show signs of autocorrelation as revealed by the AR(2) test results (both p-values are smaller than 0.05), only the rational addiction model passed both autocorrelation tests (Tables 24). Judging only by the autocorrelation test results, the rational addiction model is preferred over the other three models. However, testing for lead consumption $\ln Q_{st+1}$ in the rational addiction model is a direct test of the partial adjustment model against this model. Therefore, we cannot reject the null hypothesis that the coefficient of lead consumption in the rational addiction model is zero (t = 0.40).

Regarding the three preferred models, the estimated short-run price elasticities vary between −0.29 and −0.44, whereas the income elasticities vary between 0.11 and 0.47 (Tables 25). These estimates suggest that cigarette consumption will reduce

by about 0.3–0.4% for every 1% increase in its real price, but will increase by about 0.1–0.5% for every 1% increase in the real net national disposable income. The coefficient is –0.004 for the tobacco control scale ΔTCS_t in the error correction model, implying that cigarette consumption decreases by 0.4% for every 1-point increase in the tobacco control policy index 0–100 for Portugal. We have found only one Portuguese study that studied price elasticity estimates of demand for cigarettes over period 1980–2000 using aggregate data and the conventional model. The price elasticities were –0.29 (p = 0.10) for national brands and –0.13 (p = 0.16) for foreign brands (Barros et al. 2003).

As noted, autocorrelation still remains in the residuals of the error correction model (Table 24). It is possible that the error correction model equation needs dynamic extension, i.e., further lags of the dependent consumption variable in first differences should be included to the right-hand side of the equation. For example, at least one lagged consumption in first differences $\Delta \ln Q_{st-1}$ should be added as an additional explanatory variable to this model to cope with autocorrelation.

The recursive estimation results based on the error correction model clearly show instability, particularly at the end of the study period 2007–2009 (Appendix F10). This indicates that the error correction model was not able to accommodate the large decreases in cigarette consumption in 2007 and 2008 (Appendix F10, see graphs 'Res1 Step', '1up CHOWs', and 'Ndn CHOWs'). It is also of interest to observe that the coefficient of the tobacco control scale variable ΔTCS_t obtained its expected correct sign (negative) only after 2007, though not statistically significantly (Appendix F10, see graph 'Dtcs x +/– 2SE'). This reflects Portugal's strengthened tobacco control interventions in 2008 and the corresponding increase in the tobacco control policy index as compared to the previous year (see Table 4 and Appendix E10).

7.10 Spain

Figure 12 presents per capita cigarette consumption and the real price index in Spain over the period 1960–2009. All the three first models of demand for cigarettes show autocorrelation in the residuals (Table 26). The conventional model highly exhibits autocorrelation in the residuals as described by the two residual autocorrelation test results. Signs of autocorrelation revealed by the Ljung-Box Q(1) test result (p = 0.000) are shown for both partial adjustment and rational addiction models, but additionally the partial adjustment model did not pass the AR(2) test (p = 0.015). The error correction model is the only estimated model that does not exhibit significant residual autocorrelation and also satisfies all the model specification tests conducted (Table 26). Hence, in the conventional model, the high significance of the price elasticity estimate (t = –5.14) and the very high significance of the income elasticity estimate (t = 22.64) can be considered as signs of spurious regression (Table 26).

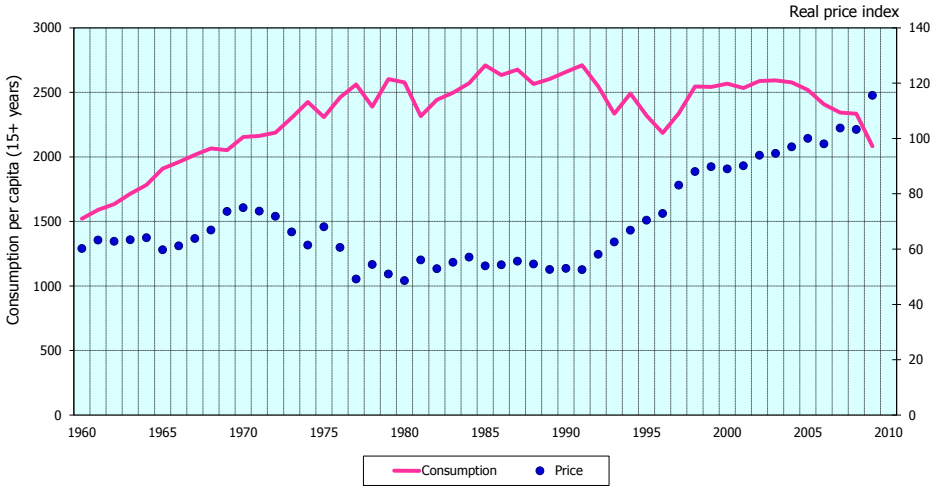

Figure 12. Consumption of cigarettes and real price of tobacco, Spain 1960–2009

The coefficients of the price and income variables $\ln P_{st}$ and $\ln Y_t$ have smaller t-values (in absolute values) when lagged consumption $\ln Q_{st-1}$ appears as an explanatory variable in the partial adjustment model. However, the coefficient of the lagged consumption variable $\ln Q_{st-1}$ in both the addiction models is negative (–0.660 and –0.539) although insignificant (t-values –1.28 and –1.06), which is clearly against our expectation (Table 26). Lead consumption $\ln Q_{st+1}$ is also statistically insignificant in the rational addiction model. Except for these two coefficients and not taking into consideration the conventional model, all other coefficient estimates in all three models come with the expected sign and all of them are statistically significant (Table 26). The income elasticity estimate (i.e., the coefficient of $\ln Y_t$) is rather high in the partial adjustment and rational addiction models, at 0.916 and 0.822 respectively, and it is a more reasonable 0.489 in the error correction model (i.e., the coefficient of $\Delta \ln Y_t$). The effect of implemented tobacco control policies on consumption captured by variable TCS_t in both addiction models and by variable ΔTCS_t in the error correction model is negative as expected and statistically significant (Table 26).

Comparing all model specification test results for the four models, we prefer the error correction model, which is the only model that passed all five model specification tests (Table 26). This model produces short-run price and income elasticity estimates of –0.349 and 0.489 respectively. In addition, in the error correction model the tobacco control scale variable ΔTCS_t is significantly and negatively related to consumption, and the adjustment coefficient is significantly negative (Table 26). Both results are in line with our hypotheses. The key estimates derived from the error correction model suggest that cigarette consumption decreases by about 3.5% for every 10% increase in its real price, while cigarette consumption increases by about

4.9% for every 10% increase in real net national disposable income. Furthermore, a 10-point increase in the tobacco control policy index will lead to a 2% decrease in cigarette consumption (Table 26).

Table 26. Estimation results from the demand models for cigarettes, Spain 1960–2009

Variable	Conventional model		Partial adjustment[a] model		Rational addiction[b] model		Error correction model	
	Coeff.	*t*	Coeff.	*t*	Coeff.	*t*	Coeff.	*t*
Constant	3.517	11.81	5.859	3.12	5.213	2.44	0.001	0.20
TCS_t	-0.003	-5.28	-0.004	-3.19	-0.004	-1.89		
lnP_{st}	-0.214	-5.14	-0.385	-2.61	-0.344	-2.42		
lnY_t	0.546	22.64	0.916	3.09	0.822	2.54		
lnQ_{st-1}			-0.660	-1.28	-0.539	-1.06		
lnQ_{st+1}					0.053	0.12		
ΔTCS_t							-0.002	-2.01
ΔlnP_{st}							-0.349	-4.60
ΔlnY_t							0.489	3.63
Adjustment coefficient							-0.512	-3.91
Model	F(3, 46) = 201.25		F(4, 43) = 46.28		F(5, 40) = 40.67		F(4, 44) = 13.30	
Adjusted R^2	0.925		0.770		0.800		0.506	
Root MSE	0.040		0.058		0.055		0.034	
Number of observations	50		48		46		49	
Test	Statistic	*p*-value	Statistic	*p*-value	Statistic	*p*-value	Statistic	*p*-value
Ljung-Box Q(1)	10.509	0.001	24.809	0.000	22.491	0.000	1.019	0.313
AR(2)	10.352	0.006	8.414	0.015	4.568	0.102	3.491	0.175
Normality	0.984	0.730	0.977	0.431	0.981	0.629	0.988	0.904
Heterosce-dasticity	13.373	0.146	20.789	0.107	27.901	0.112	12.078	0.600
RESET	0.400	0.752					2.160	0.108

[a] The instruments consist of two lag prices of cigarettes plus the other explanatory variables in the model.

[b] The instruments consist of two lead prices and two lag prices of cigarettes plus the other explanatory variables in the model.

Ljung-Box Q(1) = Ljung-Box Q test for serial correlation with one lag included.

AR(2) = Breusch-Godfrey Lagrange-multiplier test for autocorrelated residuals with two lags included.

Normality test is the Shapiro-Wilk test for normal residuals.

Heteroscedasticity test is the White test for heteroscedasticity using squares and cross products.

Table 27. Elasticity estimates of demand for cigarettes, Spain 1960–2009

Model	Price elasticity		Income elasticity
	Short run	Long run	
Conventional model	-0.214		0.546
Partial adjustment model	-0.385	-0.232	0.916
Rational addiction model	-0.344	-0.232	0.822
Error correction model	-0.349	-0.214	0.489

Elasticity estimates of demand for cigarettes for Spain are summarized in Table 27. Previous studies that have considered the impact of price on cigarette demand over several periods during 1964–2000 using aggregate data and different econometric models have provided short-run price elasticities varying mostly between –0.16 and –0.80 (Stewart 1993; Valdés 1993; Escario and Molina 2000, 2004; Fernández et al. 2004) and one estimate of –2.28 that is outside this range (Escario and Molina 2001). A previous long-run price elasticity estimate is –0.84. Because there has been a large price difference between the prices of blond cigarettes and prices of black cigarettes, the effects of prices on consumption of these two brands have been estimated. The estimated price elasticities were –0.80 and –1.25 for the consumption of blond cigarettes and alternatively –0.48 and –0.61 for the consumption of black cigarettes (Escario and Molina 2004; Fernández et al. 2004). Fernández et al. (2004) also obtained positive income elasticities 0.42 and 2.38 for the total cigarette consumption and consumption of blond cigarettes, but a negative income elasticity of –0.37 for the consumption of black cigarettes.

For the error correction model, the recursive estimation results show some significant instability (Appendix F11, see graphs 'Res1 Step', '1up CHOWs', and 'Ndn CHOWs'). For example, the tobacco control scale variable became significant only as late as after 2005 (Appendix F11, see graphs 'Dtsc x +/–2SE').

We are not able to account for the effects of illicit or cross-border trade on legal trade (i.e. official legal sale) due to the lack of reliable information on smuggling and cross-border trade and due to the long period of time for the study. It is possible that the instability in the estimated error correction model refers to smuggling. It has been estimated that 25% of the total market in Spain in the period 1960–1990 originated from smuggling, while the consumption of smuggled cigarettes reached a peak of 30% of total consumption in 1993 (Fernández et al. 2004).[19] This proportion reduced to 15% in 1995 and 5% in 1999 (Joossens and Raw 1998, 2000). Cigarette smuggling has decreased further to about 1% of total consumption in 2006 (Joossens et al. 2009). Again, we can argue that if the effect of cigarette price on demand for cigarettes were studied while taking into account illicit and cross-border trade, we would probably obtain short-run price elasticity estimates that are lower in absolute values than those obtained in this analysis.

[19] Fernández et al. (2004) cited González García (2000) and Bonilla Penvela (2003).

7.11 Sweden

For Sweden, two tobacco products for which demand is studied are cigarettes and snus. Figure 13 shows how cigarette consumption and the real price index have varied and Figure 14 how consumption of snus and the real price index have varied in Sweden in the period 1955–2009.

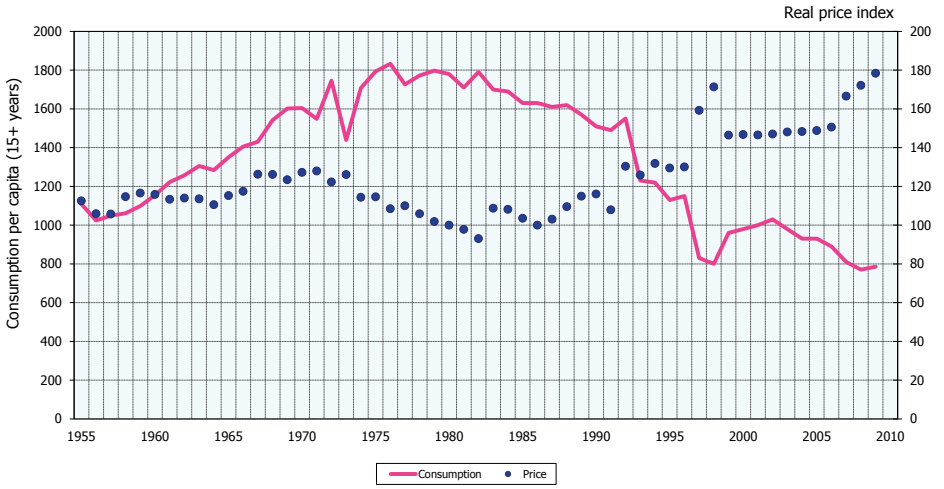

Figure 13. Consumption and real price of cigarettes, Sweden 1955–2009

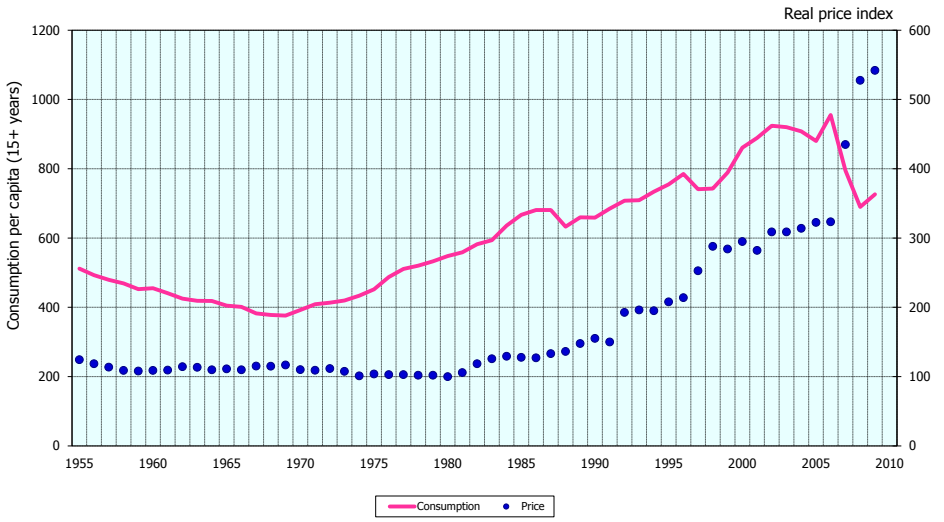

Figure 14. Consumption (g) and real price of snus, Sweden 1955–2009

Table 28. Estimation results from the demand models for cigarettes, Sweden 1955–2009

Variable	Conventional model		Partial adjustment[a] model		Rational addiction[b] model		Error correction model	
	Coeff.	*t*	Coeff.	*t*	Coeff.	*t*	Coeff.	*t*
Constant	-3.270	-2.94	-3.423	-1.97	-3.823	-1.44	-0.013	-1.14
D1960	-0.023	-0.36	-0.026	-0.38	-0.028	-0.37		
D1964	-0.093	-1.47	-0.097	-1.44	-0.106	-1.36		
TCS_t	-0.006	-4.64	-0.006	-3.05	-0.006	-1.83		
lnP_{st}	-0.229	-1.99	-0.248	-1.96	-0.251	-1.80		
lnP_{snust}	-0.445	-6.47	-0.464	-3.93	-0.563	-2.11		
lnY_t	1.183	15.45	1.243	4.08	1.417	2.21		
lnQ_{st-1}			-0.049	-0.22	-0.066	-0.23		
lnQ_{st+1}					-0.139	-0.42		
ΔD1960							-0.011	-0.27
ΔD1964							-0.074	-1.74
ΔTCS_t							-0.002	-1.13
ΔlnP_{st}							-0.399	-2.39
ΔlnP_{snust}							-0.193	-1.31
ΔlnY_t							1.248	3.02
Adjustment coefficient							-0.737	-4.90
Model	F(6, 48) = 153.51		F(7, 45) = 121.85		F(8, 42) = 74.47		F(7, 46) = 8.05	
Adjusted R^2	0.944		0.942		0.921		0.482	
Root MSE	0.062		0.064		0.070		0.058	
Number of observations	55		53		51		54	
Test	Statistic	*p*-value	Statistic	*p*-value	Statistic	*p*-value	Statistic	*p*-value
Ljung-Box Q(1)	0.568	0.451	1.501	0.221	3.967	0.046	0.117	0.732
AR(2)	9.732	0.284	0.604	0.739	1.181	0.554	0.860	0.651
Normality	0.990	0.921	0.987	0.812	0.980	0.522	0.978	0.437
Heteroscedasticity	16.146	0.305	19.763	0.473	33.788	0.172	32.966	0.105
RESET	4.360	0.009					1.550	0.215

[a] The instruments consist of two lag prices of cigarettes plus the other explanatory variables in the model.

[b] The instruments consist of two lead prices and two lag prices of cigarettes plus the other explanatory variables in the model.

Ljung-Box Q(1) = Ljung-Box Q test for serial correlation with one lag included.

AR(2) = Breusch-Godfrey Lagrange-multiplier test for autocorrelated residuals with two lags included.

Normality test is the Shapiro-Wilk test for normal residuals.

Heteroscedasticity test is the White test for heteroscedasticity using squares and cross products.

Except perhaps for the error correction models, we cannot specify demand models for Sweden's tobacco consumption that would fit well with data used as well as with our expectations of the effects of the explanatory variables on consumption (Tables 28 and 29). For example, we expect that higher prices of snus will be associated with an increase in consumption of cigarettes (in the models for cigarettes) and likewise higher prices of cigarettes associated with an increase in consumption of snus (in the models for snus), holding other factors constant. However, in all the models for demand of cigarettes, cross-price elasticities, i.e., the coefficients of the price of snus $\ln P_{snust}$ and $\Delta \ln P_{snust}$, are negative, varying from −0.193 to −0.563 (Table 28). Similarly, in all four models for demand of snus, the cross-price elasticities, i.e., the coefficients of the price of cigarettes $\ln P_{st}$ and $\Delta \ln P_{st}$, are also negative, varying from −0.131 to −1.487 (Table 29). These negative signs of the cross-price elasticity estimates are clearly against our expectations. Moreover, the first three models for snus display significant residual autocorrelation as displayed by the Ljung-Box Q(1) and Breusch-Godfrey LM AR(2) test results (Table 29).

While the conventional model does not pass the RESET test and the rational addiction model of cigarette demand exhibits some significant autocorrelation, the other two models for cigarettes seem to satisfy the model specification tests conducted (Table 28). However, in the first three models for cigarettes, while the magnitude of the short-run own-price elasticities seem to be sensible, varying from −0.23 to −0.25, the estimated positive income elasticities are surprisingly high, varying from 1.18 to 1.43 (Table 28). On the other hand, in both addiction models for snus, the own-price elasticity estimates (i.e., the coefficients of the price of snus $\ln P_{snust}$) are positive and against expectations, varying from 0.159 to 0.884 (Table 29). Thus, further investigation is called for into matters such as multicollinearity, structural stability (see Appendices F12 and F13, which show some clear instability), and possible further cointegrating relations. Due to these issues, we do not have uniquely preferred models at this stage. Considering also that lead and lag consumption are insignificant in both addictions models for both cigarettes and snus, the error correction model is the closest to being selected as the preferred model for both tobacco products.

Elasticity estimates of demand for cigarettes and snus for Sweden are summarized in Table 30. Basing interpretation on the error correction models, the short-run own-price elasticity of demand is −0.40 for cigarettes and −0.24 for snus; both of which are significant. Significant short-run income elasticity of demand for cigarettes is positive, which is very high at 1.25. The insignificant income elasticity of demand for snus is meanwhile negative, at −0.13 (Table 30). Although not significant, if we attempt to interpret the latter figure, a tentative explanation may be that users of snus with higher income will switch from snus to cigarettes and, in essence, that typical users of snus are relatively poorer than cigarette smokers.

Table 29. Estimation results from the demand models for snus, Sweden 1955–2009

Variable	Conventional model		Partial adjustment[a] model		Rational addiction[b] model		Error correction model	
	Coeff.	*t*	Coeff.	*t*	Coeff.	*t*	Coeff.	*t*
Constant	8.225	4.16	2.975	0.86	7.309	0.64	0.015	1.74
D1960	0.055	0.48	0.045	0.64	0.080	0.69		
D1964	-0.126	-1.12	-0.053	-0.66	-0.107	-0.52		
TCS_t	0.006	2.83	0.003	1.51	0.002	0.83		
lnP_{snust}	0.508	4.16	0.159	0.69	0.884	0.62		
lnP_{st}	-1.428	-7.00	-0.646	-1.25	-1.487	-0.67		
lnY_t	0.196	1.44	0.178	1.81	0.179	0.72		
$lnQ_{snust-1}$			0.556	1.53	-0.432	-0.26		
$lnQ_{snust+1}$					0.369	1.43		
ΔD1960							0.021	0.63
ΔD1964							0.008	0.24
ΔTCS_t							0.000	0.38
ΔlnP_{snust}							-0.240	-2.07
ΔlnP_{st}							-0.128	-0.94
ΔlnY_t							-0.131	-0.39
Adjustment coefficient							-0.012	-0.17
Model	F(6, 48) = 51.84		F(7, 45) = 129.61		F(8, 42) = 83.21		F(7, 46) = 1.85	
Adjusted R^2	0.850		0.950		0.930		0.101	
Root MSE	0.110		0.064		0.078		0.047	
Number of observations	55		53		51		54	
Test	Statistic	*p*-value	Statistic	*p*-value	Statistic	*p*-value	Statistic	*p*-value
Ljung-Box Q(1)	21.940	0.000	18.679	0.000	4.928	0.026	2.971	0.085
AR(2)	26.366	0.000	3.471	0.176	1.243	0.537	5.817	0.055
Normality	0.957	0.049	0.931	0.004	0.782	0.000	0.989	0.894
Heterosce-dasticity	43.575	0.000	41.148	0.004	46.236	0.012	43.966	0.008
RESET	23.690	0.000					0.820	0.488

[a] The instruments consist of two lag prices of snus plus the other explanatory variables in the model.

[b] The instruments consist of two lead prices and two lag prices of snus plus the other explanatory variables in the model.

Ljung-Box Q(1) = Ljung-Box Q test for serial correlation with one lag included.

AR(2) = Breusch-Godfrey Lagrange-multiplier test for autocorrelated residuals with two lags included.

Normality test is the Shapiro-Wilk test for normal residuals.

Heteroscedasticity test is the White test for heteroscedasticity using squares and cross products.

Table 30. Elasticity estimates of demand for tobacco products, Sweden 1955–2009

Model	Cigarettes				Snus			
	Own-price elasticity		Cross-price elasticity	Income elasticity	Own-price elasticity		Cross-price elasticity	Income elasticity
	Short run	Long run			Short run	Long run		
Conventional model	-0.229		-0.445	1.183	0.508		-1.428	0.196
Partial adjustment model	-0.248	-0.218	-0.464	1.243	0.159	0.357	-0.646	0.178
Rational addiction model	-0.251	-0.208	-0.563	1.417	0.884	0.832	-1.487	0.179
Error correction model	-0.399	-0.229	-0.193	1.248	-0.240	0.508	-0.128	-0.131

Past studies have shown that short-run own-price elasticity estimates of demand for cigarettes in Sweden mostly fall in the range −0.15 to −0.89 (Koutsoyannis 1963; Stewart 1993; Escario and Molina 2001; Bask and Melkersson 2003), although also much higher estimates have been reported (Bask and Melkersson 2003). The long-run price elasticity estimates of demand for cigarettes reported by Bask and Melkersson (2004) have typically fallen in the range −0.65 to −1.03. Bask and Melkersson (2003) also provide short-run own-price elasticity estimates of demand for snus varying between −0.07 and −5.79 and various negative cross-price elasticity estimates of demand for cigarettes and snus.

The tobacco control scale ΔTCSt has a negative estimated effect—although not significant—on consumption of cigarettes in the error correction model for cigarettes (Table 28). In contrast, it has a positive estimated effect on consumption of snus, although close to zero and statistically insignificant, in the error correction model for snus (Table 29). If this result is to be interpreted despite its small size and insignificance, tentatively the same argument could be applied as for pipe and hand-rolling tobacco in Finland. Perhaps, snus use is more difficult to detect, and laws and interventions applied to snus are less enforced than those for cigarettes. Although tobacco control policies have been directed against all forms of tobacco, in effect they affect cigarette consumers to a greater extent than users of other forms of tobacco, including snus. Hence, when tobacco control policies are strengthened, they affect cigarette smokers more effectively so that they really do lead to a reduction in cigarette smoking, but at the same time make cigarette consumers switch from cigarettes to snus. This effect, if present, is described by the positive sign of the tobacco control scale variable. It has been found that restrictive smoking laws or anti-smoking regulations in the United States may reduce cigarette consumption (Wasserman et al. 1991; Keeler et al. 1993), but do not appear to affect, for example, the use of smokeless tobacco among males (Ohsfeldt et al. 1997).

7.12 United Kingdom

Similar to the results of many other countries obtained from the conventional model, the model of demand for cigarettes for the United Kingdom shows signs of spurious correlation and under-specification of model dynamics (Table 31). This is supported by significant autocorrelation in the residuals (see test statistics of Ljung-Box Q(1) and AR(2)) and some remarkably high t-values of variables such as price $\ln P_{st}$ (t = 16.51). In particular, the estimated coefficient of the price variable $\ln P_{st}$ (i.e., price elasticity of demand) is very high at −1.05.

When lagged consumption $\ln Q_{st-1}$ is introduced as an explanatory variable in the partial adjustment model, the coefficient of $\ln P_{st}$ (i.e., the price elasticity estimate −0.542) and its t-value (−5.94) are smaller in absolute values compared to the corresponding figures in the conventional model (Table 31). In addition, the coefficient of lagged consumption $\ln Q_{st-1}$ (0.570) is positive, as expected, and statistically significant (t = 6.48). In the rational addiction model, the short-run price elasticity has come down to −0.379 (t = −4.15). Furthermore, both lagged and lead consumption, $\ln Q_{st-1}$ and $\ln Q_{st+1}$, have positive and significant coefficient estimates with the coefficient of lagged consumption $\ln Q_{st-1}$ (0.411) somewhat larger than that of lead consumption $\ln Q_{st+1}$ (0.334) (Table 31). Hence, past consumption has a greater impact on current consumption than future consumption, which is theoretically expected.

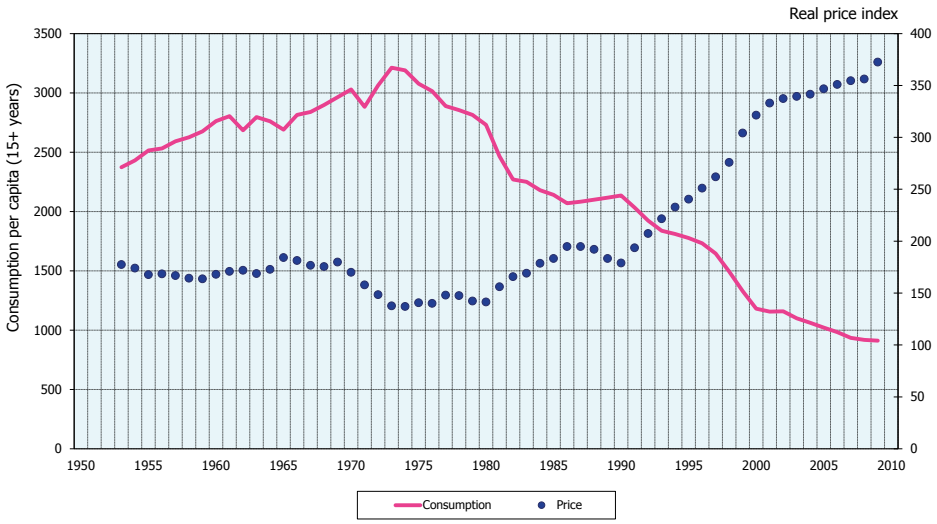

Figure 15. Consumption and real price of cigarettes, United Kingdom 1953–2009

Table 31. Estimation results from the demand models for cigarettes, United Kingdom 1953–2009

Variable	Conventional model		Partial adjustment[a] model		Rational addiction[b] model		Error correction model	
	Coeff.	*t*	Coeff.	*t*	Coeff.	*t*	Coeff.	*t*
Constant	11.501	19.46	5.017	4.48	1.940	1.45	-0.004	-0.53
D1962	0.034	1.20	-0.006	-0.31	-0.025	-1.70		
R1963	0.012	2.45	0.007	2.21	0.003	1.08		
D1971	-0.175	-4.52	-0.103	-3.73	-0.097	-4.88		
R1972	-0.020	-2.23	-0.015	-2.46	-0.006	-1.17		
D1977	0.033	0.77	0.027	0.98	0.010	0.47		
R1978	-0.030	-3.51	-0.020	-3.48	-0.012	-2.41		
D1983	0.055	1.28	0.077	2.72	0.048	2.13		
R1984	0.016	1.72	0.006	0.86	-0.002	-0.44		
TCS_t	-0.003	-6.80	-0.001	-2.07	-0.001	-2.55		
lnP_{st}	-1.046	-16.51	-0.542	-5.94	-0.379	-4.15		
lnY_t	0.200	2.29	0.134	1.75	0.232	3.86		
lnQ_{st-1}			0.570	6.48	0.411	5.44		
lnQ_{st+1}					0.334	2.85		
ΔD1962							-0.018	-0.74
ΔR1963							0.016	1.64
ΔD1971							-0.122	-4.92
ΔR1972							-0.008	-0.64
ΔD1977							0.013	0.53
ΔR1978							-0.033	-2.98
ΔD1983							0.044	1.81
ΔR1984							0.008	0.68
ΔTCS_t							-0.003	-3.34
ΔlnP_{st}							-0.711	-7.33
ΔlnYt							0.158	0.98
Adjustment coefficient							-0.262	-2.43
Model	F(11, 45) = 566.37		F(12, 42) = 1274.30		F(13, 39) = 1908.79		F(12, 43) = 11.58	
Adjusted R^2	0.991		0.997		0.998		0.698	
Root MSE	0.036		0.023		0.016		0.022	
Number of observations	57		55		53		56	
Test	Statistic	*p*-value	Statistic	*p*-value	Statistic	*p*-value	Statistic	*p*-value
Ljung-Box Q(1)	25.306	0.000	4.352	0.037	0.766	0.381	6.361	0.012
AR(2)	27.530	0.000	6.760	0.034	0.291	0.865	12.229	0.002
Normality	0.957	0.041	0.976	0.334	0.967	0.140	0.932	0.004
Heterosce-dasticity	38.500	0.112	22.613	0.308	19.701	0.602	14.860	0.672
RESET	46.280	0.000					0.680	0.570

[a] The instruments consist of two lag prices of cigarettes plus the other explanatory variables in the model.

[b] The instruments consist of two lead prices and two lag prices of cigarettes plus the other explanatory variables in the model.

Ljung-Box Q(1) = Ljung-Box Q test for serial correlation with one lag included.

AR(2) = Breusch-Godfrey Lagrange-multiplier test for autocorrelated residuals with two lags included.

Normality test is the Shapiro-Wilk test for normal residuals.

For the conventional model and the error correction model, the White test for heteroscedasticity uses squares and cross products. For three other models, the White test for heteroscedasticity only uses squares of the explanatory variables.

Income elasticity estimates vary between 0.134 and 0.232 (Table 31). In all four models, the tobacco control scale variable TCS_t or ΔTCS_t has a negative estimated coefficient that is statistically significant, implying that tobacco control policies have negatively affected cigarette consumption since 1970 onwards. However, the coefficients of the four dummy variables D1962–D1983 and those of the four trend variables R1963–R1984 do not all have the signs that we expect (Table 31). Moreover, the eight coefficient estimates of these dummy and trend variables show varying degrees of statistical significance. Considering the estimation results from the rational addiction model that meets all the model specification tests performed, variables R1972, R1978, and R1984 have negative coefficients, suggesting negative reinforcing or a returning trend in consumption, which is against our expectation (Table 31). We can argue that for example, the significant declining effect of R1978 on cigarette consumption is in accordance with the view that health scares have a cumulative impact on behaviour that has diffused new attitudes toward cigarette consumption and increased people's awareness as to the desirability of abstaining from smoking, and thus the initial impact will be reinforced as time goes on (Jones 1989). However, since this is the first study where three types of variables describing the effects of tobacco control policies on tobacco consumption are incorporated at the same time, the role of both types of dummy and trend variables in the models in relation to the use of the tobacco control scale variable should call for a re-evaluation or further examination.

In the error correction model, there is some evidence of autocorrelation in the residuals (Table 31). This may imply that additional lags of the dependent consumption variable in their first differences, such as $\Delta \ln Q_{st-1}$, $\Delta \ln Q_{st-2}$, $\Delta \ln Q_{st-3}$, ..., should be included in the right-hand side of the model equation. Among the last three estimated models, the price elasticity estimates obtained from the error correction model is, in absolute terms, highest (−0.71 vs. −0.54 and −0.38).

Elasticity estimates of cigarette demand for the United Kingdom are summarized in Table 32. We prefer the rational addiction model of cigarette demand to the other models because it is the only model that does not exhibit autocorrelation in the residuals and also passes other model specification tests (Table 31). For this model, the short-run own-price elasticity is −0.379 and the income elasticity is 0.232. A high number of studies have considered the effect of price on demand for cigarettes in the United Kingdom using different econometric models and aggregate data over several time periods from 1920–2002. These previously obtained short-run price elasticity estimates vary from +0.15 to −1.29, but most of them concentrate around a narrower range of −0.12 to −0.66, with the median estimate about −0.4 (−0.35 and −0.37) (Witt and Pass 1984; Andrews and Franke 1991;[20] Duffy 1991, 1995, 2003, 2006). Earlier reported income elasticity estimates fall within the range −0.09 to 1.01, with one estimate of 2.60 outside this range (Witt and Pass 1984; Andrews and

[20] Cited in Andrews and Franke (1991) were Stone (1945), Prest (1949), Summer (1971), Koutsoyannis (1963), Atkinson and Skegg (1973, 1974), Russell (1973), Peto (1974), McGuiness and Cowling (1975), Metra (1979), Radfar (1985), Townsend (1987), and Jones and Posnett (1988).

Franke 1991;[21] Duffy 1991, 1995, 2003, 2006). However, most of the income estimates fall in the range 0.05 to 0.41 with the median estimate at 0.23.

Table 32. Elasticity estimates of demand for cigarettes, United Kingdom 1953–2009

Model	Price elasticity		Income elasticity
	Short run	Long run	
Conventional model	-1.046		0.200
Partial adjustment model	-0.542	-1.260	0.134
Rational addiction model	-0.379	-1.485	0.232
Error correction model	-0.711	-1.046	0.158

The recursive estimation results for the error correction model show fairly stable results (Appendix F14). However, it seems that the model had some difficulties in accommodating reductions in cigarette consumption (about 11%) in 1999 and 2000 (Appendix F14, see graphs 'Res1Step', '1upCHOWs', and 'Ndn CHOWs'). This is shown by the upwards peak in the graph '1upCHOWs' and the downwards peak in the graph 'Res1Step' outside the 95% confidence bounds in 2000.

7.13 Summary of elasticities

Elasticity estimates of demand for the selected tobacco products for eleven European countries are presented in Tables 33–36. Table 33 summarizes the estimated own-price elasticities, and Table 34 the cross-price elasticities. Table 35 summarizes the income elasticities, and Table 36 the estimated coefficients of the tobacco control scale variable.

Our preferred models are indicated in Tables 33–36 by the coloured background. In some cases, i.e., France, Italy, Portugal, and Sweden, we are not fully satisfied with any of the models and thus only "half-satisfied" with some of them. This is indicated by half-coloured background in those four tables. In the case of the Netherlands, we are not satisfied with any of the models at this stage. Certainly, in these cases further econometric analyses remain to be done. For example, we abstained from analyzing the consumption of pipe and hand-rolling tobacco for Germany at this stage. As noted earlier and seen from Tables 33–36, in most cases we end up with the error correction model as the preferred model. However, for Finland, France, Germany and Portugal we also considered the rational addiction model and for Finland and Portugal the partial adjustment model as well. The United Kingdom is an

[21] Cited in Andrews and Franke (1991) were Prest (1949), Summer (1971), Atkinson and Skegg (1973, 1974), Peto (1974), McGuiness and Cowling (1975), Metra (1979), Radfar (1985), Townsend (1987), and Jones and Posnett (1988).

exception in that for this country we prefer the rational addiction model over the other models. Furthermore, for all countries, the adjustment coefficient in all the error correction models was estimated to be negative as expected, and overall it was clearly statistically significant.

Table 33. Own-price elasticity estimates of demand for tobacco products

Country	Conventional model	Partial adjustment model		Rational addiction model		Error correction model	
		SR	LR[&]	SR	LR[&]	SR	LR
Demand for cigarettes							
Austria	0.058	-0.014	-0.018	-0.071	-0.828	0.039	0.058
Finland	-0.851 ***	-0.357 *	-0.929	-0.220 #	-0.991	-0.413 **	-0.851 ***
France	-0.384 ***	-0.272 ***	-0.427	-0.067	-0.913	-0.499 ***	-0.384 ***
Germany	-1.098 ***	-0.841 ***	-1.222	-0.672 ***	-1.284	-0.788 ***	-1.098 ***
Spain	-0.214 ***	-0.385 *	-0.232	-0.344 *	-0.232	-0.349 ***	-0.214 ***
Ireland	-0.590 ***	0.850	0.930	-0.032	-5.356	-0.265	-0.590 ***
Italy	-0.372 ***	-0.439	-0.355	-0.246	-0.418	-0.373 ***	-0.372 ***
Netherlands	-1.954 ***	-1.840 ***	-2.034	-3.100 #	-1.939	-0.635 #	-1.954 ***
Portugal	-0.869 ***	-0.442 *	-2.540	-0.288	-1.016	-0.427 *	-0.869 ***
Sweden	-0.229 #	-0.248 #	-0.218	-0.251 #	-0.208	-0.399 *	-0.229 #
United Kingdom	-1.046 ***	-0.542 ***	-1.260	-0.379 ***	-1.485	-0.711 ***	-1.046 ***
Demand for pipe and hand-rolling tobacco							
Finland	-1.163 ***	-1.225	-1.050	-1.615	-1.458	-0.426 *	-1.163 ***
Netherlands	-0.734 ***	-0.717 *	-0.785	-0.681 **	-0.756	-0.551 *	-0.734 ***
Demand for snus							
Sweden	0.508 ***	0.159	0.357	0.884	0.832	-0.240 *	0.508 ***

Note. SR = Short-run price elasticity; LR = Long-run price elasticity.

Colored background indicates preferred model.

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; # $p < 0.10$.

[&] The levels of statistical significance for the long-run price elasticity estimates were not calculated.

If we look at the short-run own-price elasticity estimates of demand for cigarettes for each country and focus on the preferred model (or models) with the exception of Austria,[22] we find that most countries have estimated short-run price elasticities that vary between −0.3 and −0.4 or are close to this range (Table 33). Only Ireland and Germany are outside this interval, with an estimate of −0.265 for Ireland, which is al-

[22] For this country, the estimated price elasticity was not significantly different from zero.

most within the interval, in the lower end, and an estimate of –0.788 for Germany, at the upper end. In other words, our overall conclusion concerning how consumption of cigarettes responds to changes in its real price is that a 10% increase in real cigarette price reduces cigarette consumption by 3–4%. For pipe and hand-rolling tobacco for Finland and for snus for Sweden, our short-run own-price elasticities are generally on the same level, i.e., –0.426 and –0.240 (Table 33).

Table 34. Cross-price elasticity estimates of demand

Country	Conventional model	Partial adjustment model	Rational addiction model	Error correction model
Demand for pipe and hand-rolling tobacco with respect to cigarette price				
Finland	2.285 ***	2.341	2.742	1.733 ***
Netherlands	0.005	0.005	0.036	-0.272
Demand for cigarettes with respect to price of the other product				
Netherlands (price of pipe and hand-rolling tobacco)	0.631 ***	0.602 #	1.181	-0.451 *
Sweden (price of snus)	-0.445 ***	-0.464 ***	-0.563 *	-0.193
Demand for snus with respect to cigarette price				
Sweden	-1.428 ***	-0.646	-1.487	-0.128

Note. Colored background indicates preferred model.

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; # $p < 0.10$.

At the moment, cross-price elasticity estimates obtained from our acceptable and preferred models are only available for Finland and Sweden (Table 34). The cross-price elasticity of demand for pipe and hand-rolling tobacco with respect to cigarette prices for Finland, 1.733, is the only statistically significant one of these. This implies that a 10% increase in real cigarette price increases consumption of pipe and hand-rolling tobacco by 17%. This positive cross-price elasticity estimate suggests that pipe and hand-rolling tobacco is a substitute for cigarettes in Finland. For technical reasons, estimated long-run price elasticities are less reliable than the short-run price elasticities. In addition, short-run price elasticities are more relevant for designing pricing policy than long-run price elasticities.

Our income elasticity estimates show more variation between countries than do the short-run own-price elasticities. For cigarettes, the income elasticities of demand vary from 0.10 for Italy to 1.25 for Sweden (Table 35). However, most of the income elasticities of cigarette demand obtained lie between 0.10 and 0.60 with the median and typical estimates in the range 0.30 to 0.40. These estimates imply that typically

a 10% increase in real disposable income increases consumption of cigarettes by 3–4%. Since snus is consumed largely in Sweden, this country differs from the other countries and thus needs more detailed study.

Table 35. Income elasticity estimates of demand

Country	Conventional model	Partial adjustment model	Rational addiction model	Error correction model
Demand for cigarettes				
Austria	-0.660 ***	-0.623	-0.048	0.235
Finland	0.423 ***	0.131	0.092	0.358
France	0.499 ***	0.280 ***	0.015	0.513 **
Germany	0.245 ***	0.100	0.087	0.688 ***
Spain	0.546 ***	0.916 **	0.822 *	0.489 ***
Ireland	-0.094	-0.320	0.072	0.398
Italy	-0.081	-0.138	-0.090	0.098
Netherlands	0.104	0.145	0.338	0.214
Portugal	0.997 ***	0.467 *	0.252	0.106
Sweden	1.183 ***	1.243 ***	1.417 *	1.248 **
United Kingdom	0.200 *	0.134 #	0.232 ***	0.158
Demand for pipe and hand-rolling tobacco				
Finland	-0.836 ***	-1.111	-1.061	-1.257 *
Netherlands	-0.544 ***	-0.485 *	-0.534 #	-0.690 #
Demand for snus				
Sweden	0.196	0.178 #	0.179	-0.131

Note. Colored background indicates preferred model.

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; # $p < 0.10$.

The coefficient estimates of the tobacco control scale variable are summarized in Table 36. For cigarettes, these estimates are, with three exceptions, all negative as expected. In most cases, they are statistically significant or close to significant (Table 36). The first exception is the positive coefficient of the tobacco control scale variable for the Netherlands, for which the econometric analyses should be continued. The other two exceptional coefficient estimates with a positive sign are for Germany and Italy, but they are insignificant (t = 0.40 for Germany (see Table 15), and t = –0.43 for Italy (see Table 19)).

Concerning the effect of the implemented tobacco control policies on cigarette consumption, most of the countries have an estimated effect of –0.002 or –0.003. These estimates imply that a 10-point increase on the tobacco control scale 0–100

reduces cigarette consumption by 2% to 3%. For Austria, the estimated effect for the preferred model is clearly higher, –0.005; in other words, 10 additional points on the tobacco control scale 0–100 for Austria reduces cigarette consumption by 5%. As noted in the analysis above for Austria, this is in contrast to the lack of cigarette consumption's dependence on cigarette price or consumers' responsiveness to price. For Portugal, we also have a rather high estimate of the coefficient of the tobacco control scale variable, –0.004, but this is only for the error correction model and there are other model alternatives for Portugal. For Finland, the coefficient estimates of the tobacco control scale variable in all models of demand for pipe and hand-rolling tobacco are insignificantly positive. This is also the case for the coefficient of the tobacco control scale variable in the models of demand for snus for Sweden (Table 36). As discussed above, perhaps tobacco control policies have firstly affected cigarette smokers' behaviour and reduced cigarette smoking, which may make cigarette smokers switch from cigarettes to other tobacco products. This could explain the positive effects of the tobacco control scale variable on consumption of pipe and hand-rolling tobacco and snus.

Table 36. Coefficient estimates of the tobacco control scale in various demand models

Country	Conventional model	Partial adjustment model	Rational addiction model	Error correction model
Demand for cigarettes				
Austria	-0.002	-0.001	0.000	-0.005 #
Finland	-0.006 ***	-0.002 #	-0.001	-0.002
France	-0.006 ***	-0.003 **	0.000	-0.002 #
Germany	-0.005 **	-0.002	-0.002	0.001
Spain	-0.003 ***	-0.004 **	-0.004 #	-0.002 #
Ireland	-0.002	0.000	0.000	-0.003 **
Italy	0.001	0.002	0.002	0.000
Netherlands	0.005 *	0.004 #	0.004	0.004 *
Portugal	0.001	-0.001	0.001	-0.004
Sweden	-0.006 ***	-0.006 **	-0.006 #	-0.002
United Kingdom	-0.003 ***	-0.001 *	-0.001 *	-0.003 **
Demand for pipe and hand-rolling tobacco				
Finland	0.010 *	0.013	0.019	0.004
Netherlands	0.000	0.000	0.000	-0.001
Demand for snus				
Sweden	0.006 **	0.003	0.002	0.000

Note. Colored background indicates preferred model.

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$; # $p < 0.10$.

8 Conclusions

We have analyzed demand for tobacco products in eleven European countries to estimate price and income elasticities and explore the effect of tobacco control policies on tobacco consumption. The estimation results are reported and discussed above. Price policy and tobacco control policies have been applied to an increasing extent during the last three decades. Our results imply that both policies are clearly effective in reducing the consumption of cigarettes.

The relationship is negative between cigarette consumption and real cigarette prices both in the short term and in the long term. Short-run own-price elasticity estimates of demand for cigarettes fall mostly in a range −0.3 to −0.4. In other words, a 10% increase in the real price of cigarettes reduces cigarette consumption by 3–4%.

There is a negative relationship between real price and consumption of pipe and hand-rolling tobacco in Finland and a similar relationship between real price and consumption of snus in Sweden. The short-run own-price elasticity estimate is −0.43 for pipe and hand-rolling tobacco in Finland and −0.24 for snus in Sweden.

Long-run price elasticity estimates of demand for cigarettes range from −0.2 to −1.5, with the typical value close to −1.0. Due to technical reasons, the long-run price elasticity estimates are more variable and less reliable than the short-run price elasticity estimates and thus one should be very cautious about using the long-run price elasticity estimates.

Pipe and hand-rolling tobacco is a substitute for cigarettes in Finland.

There is a positive relationship between real disposable income and cigarette consumption. While income elasticities vary from 0.1 to 1.2, most of them fall in a range between 0.1 and 0.6. The median and typical income elasticity estimates lie between 0.3 and 0.4. In other words, a 10% increase in real disposable income increases cigarette consumption by 3–4%.

Income elasticity estimate for pipe and hand-rolling tobacco in Finland (−1.3) and that for snus in Sweden (−0.1) indicate a negative relationship between real disposable income and consumption. That is, consumption of these tobacco products fall as real disposable income rises.

Though neither statistically significant nor unambiguous, there seems to be a marginal tendency that consumption has become more responsive to changes in real prices over about the last twenty years or so, while at the same time less responsive to changes in real disposable income. Nevertheless, to better counteract the impact of increasing real disposable income on tobacco consumption, not only price policy but also other tobacco control policies have to take into account the development of real disposable income. Other factors being constant, the real prices of cigarettes should increase at about the same rate as real disposable income to keep consumption of cigarettes constant at country level.

Overall, there is a negative relationship between the tobacco control policy index and cigarette consumption. A 10-point increase in the tobacco control policy index 0–100 would reduce cigarette consumption by 0–5%. However, most estimates we produced suggest an average 2% of reduction in cigarette consumption for a 10-point increase in the tobacco control policy index.

One should remember, however, that all our conclusions above (for example, about the effect of price changes on tobacco consumption) are under the *ceteris paribus* assumption, i.e., assuming everything else remains constant. Clearly, this is not realistic. For example, an increase in the real price of a tobacco product is expected to cut down individual consumption, while growth in real household disposable income is expected to increase individual consumption. The effects of these two simultaneous changes on tobacco consumption will as noted partly mitigate each other, and thus the effectiveness of price policies in tobacco control may be reduced. Hence, evaluation and planning of tobacco price policy and other tobacco control policies have to take into account the effect of real income development on tobacco consumption.

It has been shown that previous country-specific studies of elasticity of demand for tobacco products, mainly cigarettes, are based on varying specifications of the analyzed variables and inconsistent data sources as well as on various methodological approaches (Chaloupka and Warner 2000; Gallet and List 2003). In this study, we have been able to study demand for cigarettes and some other tobacco products using similar data sets for different countries with a consistent estimation strategy and model building approach. In addition, a novel feature is the tobacco control scale variable, which has been applied in a consistent way to all the time-series data sets under study.

A rich database has been created with data from longer periods than those that are generally used. This demonstrates that in the future it will be possible to perform this type of study on tobacco demand, particularly demand for cigarettes, on a regular basis. However, the task of collecting data and the role of data quality should not be underestimated. As data for each country have not been available from one single source but have had to be gathered from various sources, we have not obtained all the desired data. In addition, in some cases, we have had to make corrections and to rely on proxy variables. For example, for three countries we had to use net national disposable income instead of the desirable household disposable income.

With aggregate time series of the type and lengths analyzed here, in contrast to some earlier studies, there is sufficient variation in the data, both in tobacco consumption and in the variables explaining it. Over longer periods of time and especially during the later phases of the time span for this study, we see trends in the time series becoming more prominent: Figures 1–14 exhibit trends in the form of increasing real prices and decreasing consumption per capita. Similarly, real disposable income per capita and the tobacco control scale exhibit rising trends (Appendices E1–E11). This type of trending in variables implies a risk that regression analysis will mainly focus on modelling and explaining a trend (in tobacco consumption) with

other trends (in price, income, and tobacco control policy index) regardless of the factual relationship between the variables. Hence, due to these trends we can expect to find strong but spurious relations between the variables.

As to spurious correlations, we can take Austria as an example. One may argue that there may not be sufficient variation in the time series for Austria and that could explain why real cigarette price does not significantly explain cigarette consumption. The real price and real income series for Austria clearly are trending (Figure 1 and Appendix E1), and indeed the variables appear to follow stochastic trends (Appendix D1). The explanation for the insignificance of the price variable for Austria (Table 8) in our view stems from the fact that real price does not follow the bumps in the consumption curve (Figure 1). This whole complex of problems also brings out the state of things concerning correlations between explanatory variables, such as price and the tobacco control scale variable, and emphasizes the need to deal appropriately with trends, as we have strived to do.

Our econometric approach has applied four different models: the conventional static model, two addiction models, and the error correction model. Our estimated models have been evaluated by diagnostic tests, in particular by tests for residual autocorrelation. We have found that specifications of the dynamic properties of the model are of particular importance for justifying reliable and meaningful results. While this is well known from the time series econometrics literature, it also became evident in this study. We conclude that there is no one single model that works for all countries and for all tobacco products.

Each country and each tobacco product constitutes an econometric challenge on its own, which should not be underestimated. A separate and detailed econometric analysis will be needed for each country and tobacco product. We have not reached satisfying models for all countries and all tobacco products as yet. Thus, we note that a number of topics remain for future research such as:

- Structural stability of the models and conclusions from the recursive estimations. Do models need to be modified to cope with structural changes or are there phenomena and factors that have not been taken into account in the models?
- Multicollinearity issues. Especially, it seems that prices of tobacco products on the one hand and tobacco control policies on the other hand as quantified in the tobacco control scale are jointly connected with each other.
- Further consideration of time-series data properties. Regression analysis with time-series data poses special challenges. In particular, the risk of spurious regression stems from the fact that the studied time series are trended regardless of whether there is any causal relation between them. It seems that in some of the models presented here the dynamics of the model may have to be further extended. There exist further alternative approaches. For example, we can apply vector autoregressive (VAR) models if we assume, in contrast to what we have done in this study, that price and perhaps also income are endogenous. This may be relevant especially for countries with more than one significant tobacco prod-

uct, which would then be handled simultaneously. State space models are another possible alternative for the kind of non-linear curves we are studying.

Cross-border trade has not been considered in this study, either as legal trade or as smuggling. Consequently, we may have received, in absolute values, too high price elasticity estimates. Studies by for example Joossens and Raw (1998, 2000) and Joossens et al. (2009) show that cross-border trade is an important issue. However, this issue is outside of the scope of the present study and should be considered in future work.

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Appendix A.

Tobacco Control Policy Index

By Laura Currie[§,#]

Introduction

Globally, it is estimated that 5 million deaths each year are attributable to smoking, with trends driving a rise to 10 million deaths per year by the 2030s.[1] Evidence suggests that a comprehensive tobacco control strategy can reduce tobacco use and associated mortality.[2,3] Evidence suggests there are six cost effective tobacco control policies which are shown to reduce tobacco use: 1) monitoring tobacco use and prevention policies, 2) protecting people from tobacco smoke, 3) offering help to quit tobacco use, 4) warning about the dangers of tobacco use, 5) enforcing bans on tobacco advertising, promotion and sponsorship, and 6) raising taxes on tobacco products.[3] When using econometric analysis to estimate the impact of price and tax increases on demand for tobacco products, it is important to include in the models other determinants of demand, such as tobacco control policies implemented in the study country.[4]

We created a Tobacco Control Policy Index (TCPI) to quantify the implementation of tobacco control policies over time (1950–2010) in study countries for use in the econometric analyses of tobacco demand presented in this report. The policies included in this TCPI include: smoke-free air laws, bans on advertising promotion and sponsorship, health warnings on tobacco product packaging and smoking cessation treatment services. The TCPI was created using the scoring system for these four policies from the Tobacco Control Scale (TCS) developed by Joosens and Raw (2006).[5] The TCS scoring system allocates points for component parts of each policy, which are summed to yield an overall annual score. The allocation of points in the TCS scoring system was based on expert consensus as described in more detail elsewhere[5] and is summarized in Table 1 for the policies we consider in this study. To the extent that tobacco tax increases are reflected in increasing tobacco product prices, tobacco taxation is captured in the econometric analyses of demand through a separate tobacco price index variable and therefore is not incorporated into the TCPI. In addition, annual data on national spending on tobacco control campaigns, which is included in the TCS, was not available for all years (1950–2010) in all study countries resulting in its exclusion from the TCPI.

Using published scores from 2005 and 2007 as a reference,[6] multiple sources were consulted to create a time series. Sources consulted include peer-reviewed literature, national and international reports and the World Health Organization To-

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bacco Control Database with corroboration from national tobacco control correspondents (listed in Table 2). Annual scores were rebased to 100, with changes in the allocated annual score reflecting changes in tobacco control policy from one year to the next. The time series index for study countries is summarized in Table 3.

While evidence began to emerge about the health risks of tobacco use in the 1950's, tobacco control policy has only developed since the publication of two seminal reports on the health risks of smoking: the 1962 British Royal College of Physicians report and the 1964 US Surgeon General's report. Despite recognition of the health risks posed by tobacco use, few Member States took action on regulating tobacco use prior to the 1980's and no EU countries had implemented policies that approximated current best practice prior to 1970. As such, all countries had a zero score prior to 1970.[7]

There are some limitations that must be considered in using the scoring system from the TCS to create an index for inclusion in this study's analyses. First, the scoring of policies within the TCS is subjective and reflects expert opinion of the relative effectiveness of policies. The predictive validity of this scale in relation to tobacco consumption has not been assessed. Second, the scoring reflects best practice in 2005 when the scale was developed. As such, it does not capture early interventions aimed at reducing tobacco consumption that are not part of current best practice. Nor does it adequately capture incremental policy changes in all policy areas. For example, the scoring system allocates points for complete bans on tobacco advertising promotion and sponsorship, but does not distinguish between legislation that restricts these activities and the no legislation in this area. However, the Tobacco Control Scale is widely referenced as a measure of country level tobacco control activity within the European Union.[8,9,10] In addition, the use of the TCPI enables us to capture in a single variable a range of tobacco control interventions consistently across study countries.

Table 1. The Tobacco Control Scale (TCS) policy scoring system*

Description of Policy Measure	Total TCS Score (max 55)	Rebased TCS Scores (max 100)
Smoking free work and other public places	22	40.00
a. Cafes and restaurants – one only of:	8	14.55
Complete ban, enforced	8	14.55
Complete ban, but with closed, ventilated, designated smoking rooms; enforced	6	10.91
Meaningful restrictions; enforced	4	7.27
Legislation, but not enforced	2	3.64
b. Public transport – additive	2	3.64
Complete ban in domestic trains without exceptions	1	1.82
Complete ban in other public transport without exceptions	1	1.82
c. Other public places	2	3.64
Complete ban in educational, health, government and cultural places, without exception OR	2	3.64
Ban in education, health, government and cultural places, but with designated smoking areas or rooms	1	1.82
d. Workplaces excluding cafes and restaurants – one only of:	10	18.18
Complete ban without exceptions (no smoking rooms); enforced	10	18.18
Complete ban, but with closed, ventilated, designated smoking rooms; enforced	8	14.55
Complete ban, but with ventilated, designated smoking rooms; enforced	6	10.91
Meaningful restrictions; enforced	4	7.27
Legislation, but not enforced	2	3.64
Comprehensive bans on advertising and promotion on July 1st of the year	13	23.64
Points for each type of ban – additive		
a. Complete ban on tobacco advertising on television	3	5.45
b. Complete ban on outdoor advertising (e.g. posters)	2	3.64
c. Complete ban on advertising in print media (e.g. newspapers and magazines)	2	3.64
d. Complete ban on indirect advertising (e.g. cigarette branded clothes, watches etc)		
e. Ban on point of sale advertising	1	1.82
f. Ban on cinema advertising	1	1.82
g. Ban on sponsorship	1	1.82
h. Ban on internet advertising	0.5	0.91
i. Ban on radio advertising	0.5	0.91

Table 1. *Continued*

Description of Policy Measure	Total TCS Score (max 55)	Rebased TCS Scores (max 100)
Large direct health warning labels on July 1st of the year	10	18.18
a. Rotating health warnings	2	3.64
b. Size of warning – one only of:	4	7.27
10% or less of packet	1	1.82
11–25% of packet	2	3.64
26–40% of packet	3	5.45
41% or more of packet	4	7.27
c. Contrasting colour (e.g. Black lettering on white background)	1	1.82
d. A picture or graphic image	3	5.45
Treatment to help dependent smokers stop	10	18.18
a. Quitline – one only of:	2	3.64
Well funded national quitline or well funded quitlines in all major regions of country	2	3.64
National quitline with limited funding or a patchwork of small local quitlines	1	1.82
b. Network of smoking cessation support (3) and reimbursement of treatment (3)	6	10.91
Cessation support network covering whole country (3); free (3)	6	10.91
Cessation support network, but only in selected areas (e.g. major cities) (2); free (3)	5	9.09
Cessation support network covering whole country (3); cost partially covered (2)	5	9.09
Cessation support network, but very limited, just a few centres (1), free (3)	4	7.27
Cessation support network, but only in selected areas (e.g. major cities) (2), costs partially covered (2)	4	7.27
Cessation support network covering whole country (3); not free (0)	3	5.45
Cessation support network, but very limited, just a few centres (1), costs partially covered (2)	3	5.45
Cessation support network, but only in selected areas (e.g. major cities) (2), not free (0)	2	3.64
Cessation support network, just a few centres (1), not free (0)	1	1.82
c. Reimbursement of medications – one only of:	2	3.64
Reimbursement of pharmaceutical treatment products	2	3.64
Partial reimbursement of pharmaceutical treatment products	1	1.82
Total score	55	100.00

* Excludes scoring for the price of cigarettes and other tobacco products and spending on public information campaigns which were included in the TCS and not included in the TCPI.
Source: Adapted from Joossens and Raw (2006).[5]

Table 2. List of Tobacco Control Country Correspondents

Name and title	Organization	Country
Dr Hanns Moshammer	Medical University of Vienna	Austria
Dr Ernest Groman	Institute of Social Medicine, Centre for Public Health Medical University of Vienna and Nicotine Institute	Austria
Dr Maria Leon-Roux	Lifestyle and Cancer Team, Section of the Environment, International Agency for Research on Cancer	France
Prof Bertrand Dautzenberg	Office Français de Prévention du Tabagisme (OFT)	France
Dr Lien Nguyen	National Institute for Health and Welfare	Finland
Dr Antero Heloma	National Institute for Health and Welfare	Finland
Dr Patrick Sandström	National Institute for Health and Welfare	Finland
Ute Mons	German Cancer Research Centre, WHO Collaborating Centre for Tobacco Control	Germany
Dr Silvano Gallus	Department of Epidemiology, Istituto Mario Negri	Italy
Matteo Franchi	Department of Epidemiology, Istituto Mario Negri	Italy
Dr Giuseppe Giorini	Environmental and Occupational Epidemiology Unit, ISPO Cancer Prevention and Research Institute	Italy
Laura Currie	TobaccoFree Research Institute	Ireland
Prof Luke Clancy	TobaccoFree Research Institute	Ireland
Daniel Rijckborst	STIVORO – for a smoke-free future	Netherlands
Prof Marc Willemsen	STIVORO – for a smoke-free future	Netherlands
Sílvia Fraga	Department of Hygiene and Epidemiology, University of Porto Medical School	Portugal
Dr Esteve Fernández	Tobacco Control Research Unit, Cancer Prevention and Control Department, Institut Català d'Oncologia	Spain
Mathias Jansson	Tobacco Control, Department of Drug Prevention, Swedish National Institute of Public Health	Sweden
Cecilia Birgersson	Tobacco Control, Department of Drug Prevention, Swedish National Institute of Public Health	Sweden
Amanda Sandford	ASH Action on Smoking and Health	England
Marloes Holtkamp	Tobacco Policy Branch, Health Improvement Division, Department for Public Health and Health Professions, Health and Social Services Directorate General, Welsh Assembly Government	Wales
Julia Hurst	ASH Action on Smoking and Health Scotland	Scotland

Table 3. Summary of annual tobacco control scores for study countries

	Country										
Year	AT	FI	FR	DE	IE	IT	NL	PT	ES	SE	UK
1950	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1951	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1952	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1953	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1954	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1955	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1956	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1957	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1958	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1959	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1960	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1961	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1962	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1963	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1964	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1965	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1966	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1967	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1968	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1969	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1970	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	5.45	0.00
1971	0.00	0.00	0.00	0.00	5.45	0.00	0.00	0.00	0.00	5.45	0.00
1972	0.00	5.45	0.00	0.00	5.45	0.00	0.00	0.00	0.00	5.45	0.00
1973	0.00	5.45	0.00	0.00	5.45	0.00	0.00	0.00	0.00	5.45	0.00
1974	0.00	5.45	0.00	6.36	5.45	0.00	0.00	0.00	0.00	7.27	0.00
1975	1.82	5.45	1.82	6.36	5.45	7.27	0.00	0.00	0.00	7.27	0.00
1976	1.82	5.45	3.64	6.36	5.45	7.27	0.00	0.00	0.00	7.27	0.00
1977	1.82	38.18	3.64	6.36	5.45	7.27	0.00	0.00	0.00	7.27	0.00
1978	1.82	38.18	3.64	6.36	5.45	7.27	0.00	0.00	0.00	7.27	0.00
1979	1.82	38.18	3.64	6.36	5.45	7.27	0.00	0.00	0.00	7.27	0.00
1980	1.82	38.18	3.64	6.36	5.45	7.27	0.00	0.00	0.00	7.27	0.00
1981	1.82	38.18	3.64	6.36	5.45	7.27	0.00	0.00	0.00	7.27	0.00
1982	1.82	38.18	3.64	8.18	5.45	7.27	0.00	0.00	0.00	7.27	0.00
1983	1.82	38.18	3.64	8.18	5.45	24.55	0.00	22.73	0.00	7.27	0.00
1984	1.82	38.18	3.64	8.18	5.45	30.00	0.00	22.73	0.00	7.27	0.00
1985	1.82	38.18	3.64	8.18	5.45	30.00	0.00	22.73	0.00	7.27	0.00
1986	1.82	38.18	3.64	8.18	6.36	30.00	0.00	22.73	0.00	12.73	0.00
1987	1.82	38.18	3.64	8.18	6.36	30.00	0.00	22.73	0.00	12.73	3.64

Table 3. *Continued*

Year	Country										
	AT	FI	FR	DE	IE	IT	NL	PT	ES	SE	UK
1988	1.82	38.18	3.64	8.18	6.36	30.00	0.00	22.73	10.91	12.73	3.64
1989	1.82	38.18	3.64	8.18	6.36	30.00	0.00	22.73	10.91	12.73	3.64
1990	1.82	38.18	3.64	8.18	6.36	30.00	15.45	22.73	10.91	12.73	9.09
1991	1.82	38.18	22.73	13.64	13.64	33.64	15.45	30.00	21.82	14.55	16.36
1992	1.82	43.64	33.64	13.64	19.09	33.64	15.45	30.00	25.45	14.55	23.64
1993	1.82	43.64	33.64	13.64	19.09	40.91	15.45	30.00	25.45	14.55	23.64
1994	1.82	47.27	33.64	13.64	19.09	40.91	15.45	30.00	31.82	50.91	23.64
1995	17.27	47.27	33.64	13.64	24.55	44.55	15.45	30.00	31.82	50.91	23.64
1996	17.27	47.27	33.64	13.64	24.55	44.55	26.36	30.91	33.64	50.91	23.64
1997	17.27	47.27	33.64	13.64	24.55	44.55	26.36	30.91	33.64	50.91	23.64
1998	17.27	47.27	33.64	13.64	24.55	44.55	26.36	30.91	33.64	54.55	23.64
1999	17.27	49.09	40.91	19.09	26.36	48.18	26.36	30.91	33.64	54.55	27.27
2000	17.27	56.36	40.91	19.09	28.18	48.18	30.00	30.91	33.64	58.18	27.27
2001	17.27	56.36	40.91	19.09	30.00	48.18	30.00	30.91	35.45	58.18	30.91
2002	22.73	61.82	40.91	22.73	32.73	50.00	41.82	34.55	39.09	58.18	30.91
2003	26.36	67.27	53.64	26.36	40.00	53.64	45.45	38.18	39.09	61.82	45.45
2004	26.36	67.27	53.64	26.36	81.82	53.64	60.00	38.18	39.09	61.82	45.45
2005	30.00	68.18	53.64	26.36	86.36	75.45	60.91	46.36	39.09	75.45	52.73
2006	38.18	68.18	53.64	27.27	86.36	75.45	60.91	46.36	73.64	75.45	69.09
2007	46.36	68.18	66.36	46.36	86.36	75.45	60.91	46.36	73.64	75.45	89.09
2008	47.27	69.09	76.36	50.00	87.27	75.45	69.09	61.82	74.55	76.36	94.55
2009	50.91	78.18	76.36	50.00	89.09	75.45	69.09	61.82	74.55	76.36	94.55
2010	50.91	78.18	76.36	50.00	89.09	75.45	69.09	61.82	85.45	76.36	94.55

Country-specific description of Tobacco Control Policy development over the study period

Austria (AT)

Annual scores and sub-scores for each of the four policies in Austria are summarized in Table 4.

Smokefree air legislation

Smokefree legislation was first introduced in Austria in 1995 and updated in 2005, 2007 and 2009. The 1995 Tobacco Act introduced restrictions on smoking in offices and some workplaces. While smoking was banned in all offices, there are exceptions to the workplace ban that allow for designated smoking rooms and the law has been poorly enforced.[11]

In 2005, a ban on smoking was introduced on public transportation including: buses, taxis, local trains, airplanes (both domestic and international) and extended to

domestic and international water transport. In 2007, the smoking ban on local trains was extended to all state run railways.[12]

An amendment to the Tobacco Act was adopted in 2008 and came into force in 2009, which extends the ban on smoking to restaurants and catering establishments where food or drink is served. However, there are many exemptions and an allowance for designated smoking areas.[11]

Austria's smokefree legislation in workplaces is allocated 2 points from 1995 onwards to represent poorly enforced legislation. Likewise, a score of 2 points is allocated for the smoking ban in bars and restaurants representing poorly enforced legislation from 2009 onwards. Smokefree legislation on public transportation in Austria was allocated 1 point for the years 2005 and 2006 and 2 points from 2007 onwards reflecting the extension of the ban to all domestic rail transport.

Tobacco advertising, promotion and sponsorship

Tobacco advertising has been banned on television and radio since 1995 (Federal Law BGB1 No. 431 (30.06.95) (excerpt) Section 11).[13] In 2006, the ban was extended to international sponsorship and print media advertising. Further, advertising was banned on outdoor billboards and in cinemas and national sponsorship was prohibited in 2007. As of 2010, there was no ban on indirect or point of sale advertising. Maximum points were allocated for each of these bans from the year they were enacted onwards.

Health warnings

Since 1975, a single small health warning, displaying the message 'Warning of the Health-Minister: Smoking may damage your health', has been required on cigarette packages in Austria. In 1995, Federal Law BGB1 No. 431 (effective 30.6.95) required that a general warning and one of eight rotating warnings be displayed covering 4% of each of the large surfaces of the package in compliance with EC Directives 89/622 and 92/41.[14] In 2003, the size of the health warning was increased to 30% of the front and 40% of the rear large surface in line with the revised EC Directive 2001/37/EC.[13] Prior to 1975, health warnings in Austria are allocated 0 points. In 1975 one point is allocated for a small health warning, increased to 4 points in 1995 for a larger, rotating health warning printed in contrasting font, and further increased to 6 points to reflect the increase in the size of the warning.

Tobacco cessation services

Smoking cessation services are managed regionally. In addition to services provided in the hospitals, there are a number of advisory centres and services run by the provinces, local health centres and health insurance funds.[12] While a network of smoking cessation services has been available in most major centres across Austria since 2002, smokers cannot access this service free of charge.[12] In most Austrian provinces, smoking cessation programmes are offered to patients at the secondary care level

by regional health insurance funds. While many are reimbursed, some funds charge for these services. In addition, a national smokers' quitline has been in operation since 2006; 2 points have been allocated for a national quitline from 2006 onwards. Lastly, there is no reimbursement for smoking cessation pharmacotherapy. Prior to 2002, Austria is not allocated any points for smoking cessation services. From 2002 onwards, we allocate 2 points for a cessation support network in selected areas and one point for partial reimbursement of the service. From 2006 onwards, we allocate 2 points for a national smokers' quitline.

Finland (FI)

Annual scores and sub-scores for each of the four policies in Finland are summarized in Table 5.

Smokefree air legislation

Finland has had meaningful workplace smoking restrictions in place since 1977, with exclusions for restaurants and bars. These restrictions extended to other public places such as cinemas, theatres and education, healthcare and governmental facilities with allowances for designated smoking areas.[15] Workplace restrictions were increased to a ban with allowances for designated smoking areas in 1994 and further tightened restrictions on smoking areas in 2009. Workplaces were allocated 4 points (meaningful restrictions, enforced) since 1977, increasing to 6 points (complete ban, but with ventilated designated smoking areas) in 1994 and further increasing to 8 points (complete ban, but with closed and ventilated designated smoking rooms) in 2009. Other public places were allocated 1 point from 1977 onwards representing a ban in education, health, government and cultural places, but with designated smoking areas or rooms.

In 2000, the law was altered to introduce smokefree areas in bars and restaurants; for example, bar service counters were designated as smokefree.[15] In 2007 the legislation was amended to prohibit smoking in bars and restaurants with an allowance for separately ventilated smoking areas. Entertainment and service were prohibited in the smoking area and tobacco smoke must not spread to smoke-free areas. There was a 2-year grace period for bars and restaurants and by June 2009, all bars and restaurants were required to be fully compliant with the amended legislation.[15] Bars and restaurants in Finland were allocated 4 points (meaningful restrictions, enforced) in 1994 and increased to 6 points complete ban, but with closed and ventilated designated smoking rooms in 2009.

The 1977 Tobacco Act restricted smoking on public transport. Since 1999, smoking has been banned on trains, taxis, buses and air travel (domestic and international) and restricted on international and domestic water transport.[13] While designated smoking areas may be established, public transportation is practically smokefree. Public transportation has been allocated 1 point since 1999 increasing to 2 points in 2009.

Tobacco advertising, promotion and sponsorship

Since 1977, there was a ban on direct and indirect advertising in cinemas, outdoor billboards, newspapers, radio, and television.[14] A ban on national sponsorship by tobacco brands was also introduced in 1977.[14] In 1995, the ban was extended to cover most indirect advertising. International sponsorship has been banned since 2005 through a technical amendment to the tobacco law.[13,15]

Health warnings

The Tobacco Act of 1977 introduced compulsory health warnings on tobacco packages.[15] In 1992, Finland introduced Ordinance No. 1504 required one of 8 rotating health warnings to be displayed on the most conspicuous side of the cigarette package covering at least 6% of the surface.[14] In 2003, Finland amended the requirements for health warnings to be compliant with the EC Directive (EC/37/2001), thus covering 32% of the front of the package and 45% of the rear of the package with one general message and one of eight rotating messages in contrasting font.[13] Since 1977, Finland was allocated 1 point for health warnings (one health warning covering less than 10% of the package), increasing to 4 points in 1992 when rotating health warnings in clear font were required and further increasing to 7 points in 2003 with the introduction of the EC Directive.

Tobacco cessation services

Treatment of tobacco dependence is part of a national health programme in Finland and services for the treatment of tobacco dependence are provided increasingly as part of primary and occupational health care.

The 1972 Health Act made funds available for the provision of smoking cessation services. These services were initially very limited and partially reimbursed in some places. By 2002, smoking cessation services had expanded within primary care and a few specialist smoking cessation clinics in selected areas. In 2002, the Finnish Medical Association and other health professional organizations adopted national consensus guidelines for smoking cessation service provision.[14] While primary care physicians are required to assess and document patients' smoking status, provision of cessation services tends to be targeted towards patients with smoking-related symptoms rather than all smokers.[12] Smoking cessation services organized by occupational health services are partially reimbursed by the Social Insurance Institute, while those provided in the public sector are mainly free of charge and reimbursement of services offered by the private sector varies widely.[12] Smoking cessation pharmacotherapy is not reimbursed in Finland.[12]

Smoking cessation is supported by a telephone quitline and a website, maintained by the Pulmonary Association Heli and funded by the Ministry of Social Affairs and Health. The quitline has been operational since 2002.[12] Smoking cessation services in Finland are allocated 3 points from 1972 onwards reflecting a limited network of support services that is partially reimbursed. This score increases to 6 in 2002 with the expansion of the services and the introduction of the quitline and web support services.

France (FR)

Annual scores and sub-scores for each of the four policies in France are summarized in Table 6.

Smokefree air legislation

The Loi Evin reinforced the Loi Veil by strengthening previously weak and unenforced smoking restrictions.[16] Specifically, the Loi Evin introduced a smoking ban in all enclosed places open to the public or considered workplaces, including: healthcare, educational and governmental facilities, theatres and cinemas. However, allowances were made for designated smoking areas and only weak restrictions apply in the cafes, bars and restaurants.[16] This legislation also bans smoking on public transport, excluding designated areas on trains. An amendment to the application decree of the Loi Evin introduced comprehensive smokefree legislation in workplaces and other public places with no allowances for designated smoking areas effective in 2007 and introduced very strict requirements for closed and ventilated designated smoking rooms in bars, nightclubs and restaurants effective in 2008.[16] In 1992, we allocate 4 points representing weak legislation in workplaces including bars and restaurants, a complete ban on public transportation (excluding allocated areas on trains) and a partial ban in other public places (health, education, government and cultural facilities). In 2007, the score increases to 12 points representing the removal of smoking areas from workplaces and in 2008 the score increases to 17 points representing the tightening of regulations in bars and restaurants.

Tobacco advertising, promotion and sponsorship

The Loi Evin introduced bans on tobacco advertising on television, radio and outdoor billboards and in print media, and bans on sponsorship and indirect marketing.[13] A ban on tobacco advertising, promotion and sponsorship on the internet came into effect in 2008. Maximum points were allocated for each of these bans from the year they were enacted onwards.

Health warnings

The Loi Veil (Loi no. 76–616 adopted 1976) introduced the first written warning on tobacco products in France.[13] The Loi Evin, which came into effect in 1992 changed the wording of the health warning to 'smoking seriously damages health'.[13] EC Directive 2001/37/EC was implemented in France in 2003, which required the warning label to occupy 30% of the main display surface and 40% of the back surface, be printed in contrasting black ink and contain one of two general warnings on the front and one of 14 rotating health warnings on the back. For health warnings, France was allocated 1 point for weak health warnings from 1976, increasing to 6 points from 2003 onwards.

Tobacco cessation treatment

In 1975, there were very few smoking cessation clinics in operation; however, in 1999 the Minister for Health formalized these services enabling financing for the expansion of cessation treatment.[17] Shortly thereafter, there were 400 hospital or community-based clinics providing support to patients who wished to quit smoking. Smoking cessation services provided by general practitioners and in hospital-based clinics have been available free of charge since 1999. Pharmacotherapy for smoking cessation was not previously reimbursed; however, in 2007, the government introduced a system of partial reimbursement whereby patients with a prescription would receive up to 50 euro once per year towards nicotine replacement therapy and varenicline through National Health Insurance. Many complementary health insurance companies would extend this to 100 or 150 euro after reimbursement from the National Health Insurance.[17] In addition, Tabac-Info-Service provides a national quitline service, which has been in operation since 2003.[18] We allocate 1 point for a few smoking cessation centres available for a fee from 1975, increasing to 5 points for an expanded service that is available free to users from 1999 onwards. We allocate 2 points for a national smokers quitline from 2003 onwards and 1 point for partial reimbursement of smoking cessation pharmacotherapy from 2007 onwards.

Germany (DE)

Annual scores and sub-scores for each of the four policies in Germany are summarized in Table 7.

Smokefree air legislation

The smokefree legislation varies for each Federal area within Germany. In 2002, regulations were enacted requiring employers to take measures to protect non-smoking staff from second-hand smoke; however, these regulations did not apply to hospitality venues.[11] In 2007, the law for the protection from the dangers of passive smoking (Gesetz zum Schutz vor den Gefahren des Passivrauchens) took effect. This law banned smoking in public and federal buildings, hospitals, airports, and railway stations.[11] From August 2007 to January 2008, laws were passed in 16 states that banned smoking in local authority buildings, educational institutions, hospitals, bars and pubs.[11] All states allowed designated smoking rooms in bars and restaurants, with the exception of Bavaria. As a result of a ruling by German Federal Constitutional Court in 2008, all states now allow smoking in small bars with an area of less than 75 square meters that do not serve food and prohibit entrance for people younger than 18 years of age, with the exception of Bavaria.[11]

Germany was allocated 2 points to reflect poorly enforced workplace legislation from 2002, increasing to 4 points reflecting the enforcement of meaningful restrictions in 2007. Likewise, a score of 4 points was allocated to cafes, bars and restaurants to reflect the enforcement of meaningful restrictions with the introduction of the 2007 legislation. From 2007 onwards, a score of 2 was allocated for public transportation and 1 for bans in other public places.

Tobacco advertising, promotion and sponsorship

Direct advertising is banned on television and radio since 1974 and in cinemas before 1800 hrs, but indirect advertising is allowed in the form of product placement on TV and in film, and in direct mail giveaways. Germany along with Austria, voted against the EU directive on tobacco advertising in 1997 and tobacco advertising is allowed in magazines and newspapers and at point of sale.[8] Companies can put tobacco brand names on non-tobacco products, and use non-tobacco brand names for tobacco products. Sponsored national events with tobacco brand names is only restricted;[12] however, international sponsorship is banned since 2006.[13]

Maximum points are allocated to Germany for a ban on TV and radio advertising since 1974, for international sponsorship since 2006, for online promotions since 2007 and for print advertising since 2008. For all other forms of direct and indirect advertising, 0 points are allocated.

Health warnings

In line with an EC Directive on tobacco labelling (89/622), Germany introduced rotating health warnings on cigarette packages covering at least 4% of each of the large surfaces of the package in 1991.[13] Then in 2003, EC Directive 2001/37/EC was implemented increasing the size of the warning to 30% of the front and 40% of the back of the package.[13] Prior to 1991, Germany is allocated 0 points for health warnings. From 1991–2002, we allocate 4 points for a small rotating message printed in contrasting font, increasing to 6 points from 2003 onwards.

Tobacco cessation services

Prior to 1999, there was no discernible network of smoking cessation services. The availability of smoking cessation treatment services varies across Germany and is particularly insufficient in the new Federal states. While services were very limited from 1999, there has been some expansion in recent years. We allocate 1 point for a very limited network of cessation services from 1999 to 2006 and 2 points for a network of smoking cessation services in major centres only from 2007 onwards. There are five smoking cessation help lines providing service in Germany since 1999[18] (2 points from 1999 onwards). There is no reimbursement of smoking cessation pharmacotherapy in Germany (0 points).

Ireland (IE)

Annual scores and sub-scores for each of the four policies in Ireland are summarized in Table 8.

Smokefree air legislation

Prior to 1995 there were no legislated restrictions on smoking in indoor workplaces or public places. The Tobacco (Health Promotion and Protection) Act of 1988 gave

the Minister for Health the power to prohibit or restrict the consumption of tobacco products in designated areas in defined places; however, the Minister for Health did not exercise this power. In the early 1990's, a voluntary code of practice restricting smoking in the workplace was agreed between the Irish government, employers, and trade unions, but the voluntary approach did not work and restrictions were largely ignored.[19] In 1995, the Department of Health enacted the Tobacco (Health Promotion and Protection) Regulations, which restricted smoking in all public or shared areas of government buildings, any part of child care centres, all educational institutions, food preparation and retail areas, waiting areas of public transport stations, and indoor entertainment venues.[19] In 2004, the Public Health Tobacco (Amendment) Act introduced a comprehensive smoke-free law, which applied to all worksites, including bars and restaurants with allowances for designated smoking areas in prisons, nursing homes and psychiatric hospitals.[19] Ireland is allocated 0 points for smokefree legislation for all years prior to 1995. From 1995 onwards, 2 points are allocated for a comprehensive ban in public transport and 1 point is allocated for bans on smoking in education, health, government and cultural places, but with designated smoking rooms. From 2004 onwards, the maximum score is allocated for comprehensive smoking bans in bars and restaurants (8 points) and workplaces (10 points).

Tobacco advertising, promotion and sponsorship

Since 1971 there was a legislative ban on advertising on national TV,[20] extending to radio in 1979.[21] Legislation in 2002 extended the advertising ban to include some forms of sponsorship and indirect marketing, such as mail giveaways, promotional discounts, and sponsored events. In 2004, legislation was extended to all forms of direct advertising in major media, including print media, cinemas and billboards, and more indirect advertising (ban on packages less than 20 sticks, sponsorship misleading false packaging); however, some forms of sponsorship, brand stretching, point of sale, and product placements were still allowed. In July 2009, a ban on point of sale advertising was implemented. For all years prior to 1971, Ireland was allocated 0 points for tobacco advertising promotion and sponsorship restrictions. Ireland was allocated full points for bans on tobacco advertising on TV from 1971, radio from 1979, national sponsorship from 2002, cinema, billboards and print from 2004, international sponsorship and indirect advertising from 2005, internet advertising from 2008 and point of sale advertising from 2009.

Health warnings

Health warnings were first introduced in 1991 based on the 1991 statute requiring one of 8 rotating health warnings in contrasting font.[22] Since May 2002, Ireland has had rotating warnings, which cover 30% of the package in front and 40% of the package on the back in accordance with EU requirements. After a high court settlement in January 2008, all tobacco products are required to carry health warnings in

both English and Irish and thus the warning size was increased to 32% of the front of the package and 45% of the rear of the package in accordance with EC Directive EC/37/2001. The warnings are not graphic or pictorial. Prior to 1991, Ireland was allocated 0 points for health warnings, maximum points were allocated for rotating and contrasting health warnings of limited size from 1991 onwards, and maximum points for the size of the health warning were introduced from 2002 onwards. No points were allocated for graphic images.

Tobacco cessation services

Prior to 1992, there was no formal network of smoking cessation services in Ireland. In the early 1990s smoking cessation training was first made available and minimal services were provided, free of charge to patients, in a few hospitals or health centres. These services expanded in the late 1990s with the launch of national health strategies.[23,24] In 1999 the National Smokers Quitline began providing counselling services. In 2003, as part of a national anti-smoking campaign 'Every cigarette is doing you damage', the National Smokers Quitline was expanded and re-launched and smoking cessation services came under the mandate of the National Health Service Executive. Partial reimbursement of pharmacotherapy has been available since 2001. NRT has been available on prescription free of charge to medical card holders in Ireland (29% of the population) since April 2001; those without medical cards have to pay for prescription items up to a total of €100 per month, in addition to fees for attending GPs to obtain a prescription. Prior to 1992, Ireland was allocated 0 points for smoking cessation services. In 1992, 3 points were allocated for a limited network of partially reimbursed cessation services, increasing to 4 points in 1999 for an expanded network of services and further increased to 5 points in 2003 for a national network of services. In 1999, 1 point is allocated for a limited smoker's quitline, increased to 2 points in 2003 when the quitline was expanded and re-launched. From 2001 onwards, 1 point was allocated for the partial reimbursement of smoking cessation pharmacotherapy.

Italy (IT)

Annual scores and sub-scores for each of the four policies in Italy are summarized in Table 9.

Smokefree air legislation

Legislation enacted in 1975 (Law n. 584 of the 11th November 1975) prohibited smoking on hospital wards, in school classrooms, libraries, cinemas, museums, and in public transport (including indoor/underground stations and excluding smoking areas on trains). Smoking areas were provided on trains. Further, the legislation prohibited smoking in any indoor premises used for public assembly such as cinemas or theatres, museums or galleries, libraries and meeting rooms.[25] In 1995, a directive was issued (Directive of Ministries of the 14th December 1995) tightening this legis-

lation by extending the range of areas covered by the legislation with particular impact on indoor workplaces (e.g. offices). In 2005, Italy introduced more comprehensive smokefree legislation which made public transport completely smokefree and extended coverage to bars and restaurants. While allowances were made for closed and ventilated designated smoking areas, the regulations governing these areas were very strict making it prohibitively expensive and infeasible for most premises to implement them. As such, the smoking ban was practically complete and universally observed. We allocate 4 points for weak legislation in indoor workplaces, a partial ban in other public places and a complete ban on public transport (excluding rail services) from 1975. In 1995, we increase the score to 6 points reflecting the extension of the smoking restrictions in indoor workplaces and further increase the score to 17 points with the enactment of the relatively comprehensive smoking ban in 2005.

Tobacco advertising, promotion and sponsorship

Legislation enacted in 1983 (Law n. 52 of the 22 February 1983) introduced a ban on tobacco advertising on television and radio, in cinemas or print media, on outdoor billboard displays and restricted point of sale advertising. In 1991, most indirect advertising was banned (Ministry Decree n. 425 of the 30th November 1991) and sponsorship by tobacco brands was banned in 2005 (Decree n. 300 of the 16th December 2004). Maximum points were allocated for each of these bans from the year they were enacted onwards.

Health warnings

In 1993, Italy implemented EU Directives 89/622/EEC and 92/41/EEC requiring health warnings containing one general and one rotating health warning, in contrasting font, covering 4% of front and back sides of the cigarette package.[13] EC Directive 2001/37/EC was implemented in Italy in 2003 which required the warning label to occupy 30% of the main display surface and 40% of the back surface, be printed in contrasting black ink and contain one of two general warnings on the front and one of 14 rotating health warnings on the back.[13] For health warnings, Italy was allocated 4 points from 1993, increasing to 6 points from 2003 onwards.

Tobacco cessation treatment

While very limited smoking cessation services have been available since 1983, most services began between 1999 and 2003.[26] By 2007, there were over 300 smoking cessation services available across the country provided by the National Health System and the Italian League Against Cancer; however, several services are inadequately funded and their activities are only periodically implemented.[26] The National Health System provides very limited reimbursement for smoking cessation support services[26] and pharmacotherapy for smoking cessation is not reimbursed.[27,28] Brief intervention for smoking cessation began in 2000, with Italian Clinical Practice Guidelines for Smoking Cessation published thereafter in 2002. A national quitline

provided by the Italian League Against Cancer has been in operation since 1999, with an additional quitline service provided by the Italian National Institute of Health beginning in 2000.[29] We allocate 3 points for a very limited and partially reimbursed smoking cessation support network from 1983 increasing to 4 points for a partially reimbursed smoking cessation network in selected areas from 2002 onwards. We allocate 2 points from 1999 onwards for a national smokers quitline.

The Netherlands (NL)

Annual scores and sub-scores for each of the four policies in the Netherlands are summarized in Table 10.

Smokefree air legislation

The Dutch Tobacco Act contains measures for controlling the use of tobacco and protecting non-smokers against exposure to tobacco smoke. The 1988 Tobacco Act came into force on 1 January 1990 and had a limited scope. Smoking restrictions only applied to government buildings and certain categories of buildings in the 'semi-public sector' such as institutions for education and healthcare. The Tobacco Act was amended in 2004 to introduce smoke-free working places with ventilated smoking rooms permitted and a complete ban on smoking in public transport and in 2008 to introduce smoking restrictions in the hospitality, sport and art/culture sectors, again with allowances for smoking areas. We allocate 1 point for restrictions on smoking in healthcare, educational and government facilities from 1990 onwards. We allocate 6 points for a complete ban with ventilated designated smoking rooms in workplaces and 2 points for a complete ban on smoking in public transport from 2004 onwards. Lastly, we allocate 4 points for the enforcement of meaningful restrictions on smoking in cafes, bars and restaurants from 2008 onwards.

Tobacco advertising, promotion and sponsorship

Tobacco advertising, promotion and sponsorship have been banned in the Netherlands on television and radio since 1990, and in cinemas since 1996. It has also been banned on billboards since 2002 and print media since 2003.[13] Restrictions on indirect advertising and marketing – sponsorship, use of logos, and certain types of discounts – have also been banned since 2002.[13] We allocate maximum points for bans on tobacco advertising on television and radio from 1990, in cinemas from 1996, on outdoor billboards since 2002 and in print media since 2003. Maximum points are allocated for bans on sponsorship and indirect advertising from 2002, with bans on international sponsorship taking effect in 2005 and internet advertising bans effective 2008.

Health warnings

Since 1990, the Netherlands has had health warnings featuring on cigarette packs according to EC directives on labelling 89/622/EEC and 92/41/EEC.[13] A general health

warning and an additional rotating warning was required on all cigarette packages, clear and legible in contrasting font and covering at least 4% of the front and rear of the package. In 2002, legislation on health warnings was amended to comply with EU Directive (2001/37/EC) such that the warning would carry the general message and one of 14 rotating health messages covering 30% of the front and 40% of the back of the package.[13] Graphic images are not required. The Netherlands was allocated 4 points for health warnings from 1990, increasing to 6 points from 2002 onwards.

Tobacco cessation treatment

A network of smoking cessation treatment services has been available in some health care (hospital and health provider offices) facilities across the country since 1996 (3 points). The reimbursement of these services depends on the type of insurance coverage and the insuring company; as such, it has been classified as partial reimbursement from 1996 onwards (2 points).[12] While nicotine replacement is available at pharmacies and buproprion is available through prescription, there is no reimbursement for pharmacotherapy. A national smokers' quitline has been in effect since 2000 (2 points).

Portugal (PT)

Annual scores and sub-scores for each of the four policies in Portugal are summarized in Table 11.

Smokefree air legislation

Smoking has been restricted to designated smoking areas in healthcare, educational and government facilities, theatres and cinemas, indoor workplaces (excluding hospitality sector) and offices since 1983.[13] In addition, smoking was banned on buses, trains and water transport for journeys of less than one hour and restricted to designated smoking areas for longer journeys.[13]

In 2008, Portugal banned smoking in all government buildings without exception, workplaces, rented accommodation, reception areas, health and medical facilities, retirement homes, orphanages, all education and sport facilities, museums, libraries, theatres, food and beverage establishments, airports, bus and train stations, covered car parks and ATM vestibules.[11] Smoking areas can be designated provided they are closed, ventilated and meet size requirements and Portuguese bars smaller than 100 sq m (1,076 sq ft) can still opt to allow smoking.[11]

From 1983 onwards, we allocate 2 points for workplace smoking restrictions representing weak legislation and 1 point each for smoking restrictions in public transport and public places (including: healthcare, educational, and governmental facilities and theatres and cinemas) (total 4 points). From 2008 onwards, we allocate 4 points each for the enforcement of meaningful restrictions in hospitality premises and indoor workplaces with allowances for designated smoking areas, 2 points for a complete ban on public transport and 1 point for a ban in public places with allowances for designated smoking areas (total 11 points).

Tobacco advertising, promotion and sponsorship

In Portugal, tobacco advertising, promotion and sponsorship has been banned on television and radio, in national and local magazines and newspapers, on billboards and at the cinema since 1983. It is not yet banned at the point of sale (Decree no. 226/83, Decree no. 330/90 (Advertising rule), Decree no. 275/98).[13] National sponsorship by tobacco brands was banned in 1996 (Decree law no. 226/83 (27.5.83) amended by Decree no. 275/98 (enacted 9.9.1998) and Decree no. 330/90 (Advertising Rule)(enacted 23.10.1990).[13] Internet advertising banned in 2005 and indirect advertising is not yet comprehensively banned in Portugal.[13] Maximum points were allocated for Portugal for bans on tobacco advertising on television, radio, billboards, in print media and in the cinema from 1983 onwards. Maximum points were allocated for a ban on national tobacco sponsorship from 1996 onwards, international tobacco sponsorship from 2008 onwards and internet advertising from 2005 onwards.

Health warnings

According to Portaria 821/91, which implemented EU Directives 89/622/EEC and 92/41/EEC, health warnings were required to contain one general and one rotating health warning in contrasting font covering 4% of front and back sides of the cigarette package.[12] EC Directive 2001/37/EC was implemented in Portugal in 2003 which required the warning label to occupy 30% of the main display surface and 40% of the back surface, be printed in contrasting black ink and contain one of two general warnings on the front and one of 14 rotating health warnings on the back.[13] For health warnings, Portugal was allocated 4 points from 1991, increasing to 6 points from 2003 onwards.

Tobacco cessation treatment

Primary healthcare reform in 2005 expanded smoking cessation services within the primary care setting. The Tobacco Law of 2007 introduced specific clinical appointments for smoking cessation and expansion of the network of support. Portugal currently has five regional health administrations responsible for providing smoking cessation services within each region. A smoking cessation support network including physicians, nurses and psychologists is available across these five regions.[12] While some private services charge a fee, smoking cessation services at primary and secondary care level are fully reimbursed and widely available.[12] Pharmacotherapy to support smoking cessation is not currently reimbursed in Portugal.[12] In addition, Portugal introduced a smokers quitline in 2002.[18] We allocate 2 points for a quitline from 2002 onwards, 4 points for a limited network of smoking cessation services with full reimbursement from 2005, increasing to 5 points for a network available in selected areas with full reimbursement from 2008 onwards.

Spain (ES)

Annual scores and sub-scores for each of the four policies in Spain are summarized in Table 12.

Smokefree air legislation

In 1988, a royal decree was imposed which introduced a complete ban on smoking in healthcare facilities, education facilities, theatres, cinemas, buses, air transport and some taxis. In addition, this decree introduced a partial restriction on smoking in government facilities, indoor workplaces and offices.[13] In 2006, Spain introduced tighter legislation (Ley 28/2005), which banned smoking in all enclosed public and private workplaces, all indoor public places, public transportation including closed stations, hospitals and other health care facilities, schools and universities, as well as retail stores and shopping centres.[30] According to this legislation, larger hospitality venues of greater than 100m^2 could opt to introduce a smoking area of less than 30% of the total area, while venues smaller than 100m^2 could opt out of introducing a smoking ban. In 2010, an amendment to the smokefree legislation was adopted (effective 2011), which introduces smokefree bars and restaurants with no exceptions. We allocate 5 points for a complete ban on smoking in public transport and a partial ban on smoking in workplaces and other public places (healthcare, education and government facilities) from 1989 onwards. In 2006, the score increases to 15 points with the extension of the legislation, and in 2010 it increases further to 21 points.

Tobacco advertising, promotion and sponsorship

In 1994, legislation was introduced which bans tobacco advertising on national and cable television and national radio (Ley 25/1994 incorporating Directive 89/552/EC).[13] The tobacco legislation enacted in 2006 (Ley 28/2005) introduces a comprehensive ban on tobacco advertising, promotion and sponsorship in all public and private media.[30] Maximum points were allocated for a ban on advertising on television and radio from 1994 and for all other advertising, promotion and sponsorship activities from 2006 onwards.

Health warnings

In 1988, Spain introduced its first health warning on cigarette packages. In 1992, health warnings were strengthened in line with EC Directive 92/41/EEC, which required health warnings to display one general and one rotating health warning in contrasting font covering 4% of front and back sides of the cigarette package.[13] Spain introduced EC Directive 2001/37/EC (Royal Decree 1079/2002), which required the warning label to occupy 30% of the main display surface and 40% of the back surface, be printed in contrasting black ink and contain one of two general warnings on the front and one of 14 rotating health warnings on the back.[13] Spain is allocated 1 point for a weak health warning from 1988, increasing to 4 points with the adoption of EC Directive 92/41/EEC and further increasing to 6 points with the adoption

of EC Directive 2001/37/EC. While Spain does not currently require graphic health warnings, these are due to take effect in 2012.

Tobacco cessation treatment

Assistance from a physician in primary care or from specialized smoking cessation units have been available at no cost to patients since the early 1990s, with the availability of services expanding with available resources. While accessing treatment services is free through the National Health Service, the cost of pharmacotherapy for smoking cessation is generally not reimbursed with regional differences due to Spain's decentralized health system.[12] In addition, a network of regional smokers' quitlines has been in operation since 2001, although national coverage does not exist. We allocate 5 points representing a network of cessation support services in selected areas or regions available free of charge from 1991, increasing to 6 points with the expansion of the network in 1996 and further increasing to 7 points with the introduction of a limited network of regional quitlines.

Sweden (SE)

Annual scores and sub-scores for each of the four policies in Sweden are summarized in Table 13.

Smokefree air legislation

The Swedish Tobacco Act was enacted in 1993 and 1994. This legislation restricted smoking in healthcare facilities, education facilities, government facilities, indoor workplaces and offices, theatres and cinemas, and hospitality venues with allowances for smoking areas and prohibited smoking on buses, trains, taxis, domestic international air transport.[13] In 2005, smoking became prohibited by law in businesses selling food and drinks including restaurants, bars and nightclubs, with allowance for closed and ventilated designated smoking areas.[31] In addition, tighter controls on smoking rooms were introduced in workplaces with the 2005 amendment. We allocate 2 points for weak legislation in cafes and bars from 1994, increasing to 6 points in 2005 for a complete ban with closed and ventilated designated smoking rooms. From 1994 onwards, we allocate maximum points for a ban on smoking in public transport and 1 point for a ban on smoking in public places such as healthcare facilities, education facilities, government facilities, with allowances for designated smoking areas. With regard to workplaces, we allocate 4 points representing enforcement of meaningful restrictions from 1994, increasing to 6 points for a complete ban with closed and ventilated designated smoking rooms from 2005 onwards.

Tobacco advertising, promotion and sponsorship

The National Tobacco Act enacted in 1994 introduced a complete ban on direct and indirect tobacco advertising in broadcast and print media, in cinemas and on outdoor billboards and banned national tobacco sponsorship.[31] Point of sale advertis-

ing restrictions and a ban on international sponsorship were introduced in 2005 and restrictions on internet advertising and promotion were introduced in 2008.[13]

Health warnings

As a result of the 1974 report of the National Board of Health and Welfare, a health warning has been required on tobacco packages since 1975.[31] In 1986, an Act concerning warning text and declaration of contents of tobacco goods (No. 10 of 1986) was enacted which required one of thirteen rotating health warnings to be displayed in bold letters on a contrasting background covering at least 4% of the package.[14] Legislation relating to health warnings was further updated to be consistent with the EC Directive (2001/37/EC) in 2004. The amendment required larger health warnings covering at least 30% of the main display surface and 40% of the other largest surface to contain one general and one of fourteen rotating health warnings.[13] Graphic images are not required in Sweden. We allocated 1 point for a single small health warning from 1975, increasing to 4 points for a rotating health warning covering less than 10% of the pack in 1986 and further increasing to 6 points in 2003 with the increase in the warning size.

Tobacco cessation treatment

Cessation services were first introduced in the early 1970s on a very limited basis in primary care facilities. The coverage of services has grown in intensity over the years with increased investment in the 1990s and further in the 2000s and have always been partially reimbursed (with regional differences). Currently, between 56–73% of primary care units provide help to support tobacco users who want to quit and there are regional differences in the intensity of services and resources allocated.[12] Clinic attendance for cessation services is either free or low cost;[12] the cost of a health visit is determined by each of the 21 county councils in Sweden and are included in a high cost threshold receiving partial state subsidy. Currently nicotine replacement therapy is not reimbursed, but is available over the counter. Prescription products such as varenicline and buprprion have been partially reimbursed since 2000, but there are regional differences. Sweden launched its national smokers quitline in 1998.[31] We allocated 3 points for a very limited network of cessation services with partial reimbursement from 1971, increasing to 4 points in 1991 and 5 points in 2000 with the expanded network. In addition, 2 points were allocated from 1998 onwards for the smokers quitline and 1 point was allocated for partial reimbursement of smoking cessation pharmacotherapy from 2000 onwards.

United Kingdom (UK)

Annual scores and sub-scores for each of the four policies in UK are summarized in Table 14.

Smokefree air legislation

Comprehensive smoke-free legislation covering virtually all enclosed public places and workplaces including bars and restaurants has been enacted throughout the UK. Scotland was the first to implement a legal ban on smoking in the UK in 2006. The Health Act received Royal Assent and came into effect in April 2007 in Wales and Northern Ireland and in July 2007 in England. Considering the UK as a single entity, 1 point is allocated for a ban on public transport in 2005, increasing to 10 points in 2006 as Scotland introduced comprehensive smokefree legislation, with a further increase to 21 points as all jurisdictions within the UK introduced comprehensive smokefree legislation.

Tobacco advertising, promotion and sponsorship

The Broadcasting Act of 1990 introduced a ban on tobacco advertising on television.[13] The Tobacco Advertising and Promotion Act came into effect in phases, with the first phase effective in 2003.[32] The Act introduces prohibition on any advertisement promoting a tobacco product including adverts in print and broadcast media, billboards, the Internet, direct mail, and product placement. The legislation also bans promotions, free gifts, coupons and sponsorships, where the aim or effect is to promote a tobacco product.[32] Some limited advertising is permitted at the point of sale and regulations allow for 'brand-sharing' provided that the branding of the non-tobacco product is sufficiently distinct from the tobacco brand. The second phase was enacted in 2005 when indirect advertising and tobacco sponsorship was banned.[32] The UK was allocated maximum points for a ban on tobacco advertising on television in 1990, radio, cinema, outdoor billboards, print media, and the internet in 2003, and sponsorship and indirect advertising in 2005.

Health warnings

Health warnings on cigarette packages have been required since 1991.[33] This act required a general health message on the most visible surface of the pack and a rotating message on the back surface, printed clearly and legibly in contrasting font covering at least 6% of the surface. In compliance with the EU Tobacco Products and Labeling Directive of 2001, the Tobacco Products (manufacture, Presentation and Sale) (Safety) Regulation 2002 legislated for larger, hard-hitting health warnings on tobacco packages, which were introduced in 2003. These changes required one of two general warnings covering 30% of the front surface (smoking kills, or smoking seriously harms you and others around you) and one of 8 rotating warnings covering 40% of the back surface. In addition, pictorial warnings were introduced in late 2008, which will replace the written warnings on the back of the pack.

Tobacco cessation services

The UK has had a quitline service available since 1987.[18] In 1992, the National Health Service General Medical Services Regulations came into effect which required doc-

tors to advise patients about the significance of tobacco use and where appropriate to advise against smoking as part of the service they provide their patients. The 1998 UK White Paper on Tobacco Smoking Kills, mobilized substantial investment in smoking cessation services in each of the four UK countries.[34] The expansion of services enabled General Practitioners to refer smokers motivated to quit to a course of specialist counselling, advice and support. Expansion of services was initially targeted towards areas of greatest need[34] and services have since reached national coverage. In 2001, all forms of nicotine replacement therapy were made available free of charge on prescription. From 1987, the UK was allocated 2 points for having a quitline service, increasing to 6 points in 1992 with the introduction of a very limited free smoking cessation service, further increasing to 8 points in 1999 with the expansion of cessation services and to 10 points with the introduction of free nicotine replacement therapy in 2001.

Table 4. Austria – Annual scores and sub-scores for each of the four tobacco control policies

	Smokefree public places					Bans on tobacco advertising											Health Warnings					Tobacco Cessation Treatment				Total	
	a.	b.	c.	d.	Total	a.	b.	c.	d.	e.	f.	g.	h.	i.	j.	Total	a.	b.	c.	d.	Total	a.	b.	c.	Total	Total TCS Score	TCS Index Re-based
1950	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
1975	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	1.82
1976	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	1.82
1977	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	1.82
1978	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	1.82
1979	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	1.82
1980	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	1.82
1981	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	1.82
1982	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	1.82
1983	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	1.82
1984	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	1.82
1985	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	1.82
1986	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	1.82
1987	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	1.82
1988	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	1.82
1989	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	1.82
1990	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	1.82
1991	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	1.82
1992	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	1.82
1993	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	1.82
1994	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	1	1.82
1995	0	0	0	2	2	3	0.5	0	0	0	0	0	0	0	0	4	2	1	1	0	4	0	0	0	0	10	17.27
1996	0	0	0	2	2	3	0.5	0	0	0	0	0	0	0	0	4	2	1	1	0	4	0	0	0	0	10	17.27
1997	0	0	0	2	2	3	0.5	0	0	0	0	0	0	0	0	4	2	1	1	0	4	0	0	0	0	10	17.27
1998	0	0	0	2	2	3	0.5	0	0	0	0	0	0	0	0	4	2	1	1	0	4	0	0	0	0	10	17.27
1999	0	0	0	2	2	3	0.5	0	0	0	0	0	0	0	0	4	2	1	1	0	4	0	0	0	0	10	17.27
2000	0	0	0	2	2	3	0.5	0	0	0	0	0	0	0	0	4	2	1	1	0	4	0	0	0	0	10	17.27
2001	0	0	0	2	2	3	0.5	0	0	0	0	0	0	0	0	4	2	1	1	0	4	0	0	0	0	10	17.27
2002	0	0	0	2	2	3	0.5	0	0	0	0	0	0	0	0	4	2	1	1	0	4	0	3	0	3	13	22.73
2003	0	0	0	2	2	3	0.5	0	0	0	0	0	0	0	0	4	2	3	1	0	6	0	3	0	3	15	26.36
2004	0	0	0	2	2	3	0.5	0	0	0	0	0	0	0	0	4	2	3	1	0	6	0	3	0	3	15	26.36
2005	0	1	1	2	4	3	0.5	0	0	0	0	0	0	0	0	4	2	3	1	0	6	0	3	0	3	17	30.00
2006	0	1	1	2	4	3	0.5	0	0	2	0	0	0.5	0	0	6	2	3	1	0	6	2	3	0	5	21	38.18
2007	0	2	1	2	5	3	0.5	1	2	2	0	0.5	0.5	0	0	10	2	3	1	0	6	2	3	0	5	26	46.36
2008	0	2	1	2	5	3	0.5	1	2	2	0	0.5	0.5	0.5	0	10	2	3	1	0	6	2	3	0	5	26	47.27
2009	2	2	1	2	7	3	0.5	1	2	2	0	0.5	0.5	0.5	0	10	2	3	1	0	6	2	3	0	5	28	50.91
2010	2	2	1	2	7	3	0.5	1	2	2	0	0.5	0.5	0.5	0	10	2	3	1	0	6	2	3	0	5	28	50.91

Table 5. Finland – Annual scores and sub-scores for each of the four tobacco control policies

	Smokefree public places					Bans on tobacco advertising											Health Warnings					Tobacco Cessation Treatment				Total	
Year	a.	b.	c.	d.	Total	a.	b.	c.	d.	e.	f.	g.	h.	i.	j.	Total	a.	b.	c.	d.	Total	a.	b.	c.	Total	Total TCS Score	TCS Index Rebased
1950	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
1972	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	3	5.45
1973	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	3	5.45
1974	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	3	5.45
1975	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	3	5.45
1976	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	3	5.45
1977	0	0	1	4	5	3	0.5	1	2	2	1	0.5	0	0	2	12	0	1	0	0	1	0	3	0	3	21	38.18
1978	0	0	1	4	5	3	0.5	1	2	2	1	0.5	0	0	2	12	0	1	0	0	1	0	3	0	3	21	38.18
1979	0	0	1	4	5	3	0.5	1	2	2	1	0.5	0	0	2	12	0	1	0	0	1	0	3	0	3	21	38.18
1980	0	0	1	4	5	3	0.5	1	2	2	1	0.5	0	0	2	12	0	1	0	0	1	0	3	0	3	21	38.18
1981	0	0	1	4	5	3	0.5	1	2	2	1	0.5	0	0	2	12	0	1	0	0	1	0	3	0	3	21	38.18
1982	0	0	1	4	5	3	0.5	1	2	2	1	0.5	0	0	2	12	0	1	0	0	1	0	3	0	3	21	38.18
1983	0	0	1	4	5	3	0.5	1	2	2	1	0.5	0	0	2	12	0	1	0	0	1	0	3	0	3	21	38.18
1984	0	0	1	4	5	3	0.5	1	2	2	1	0.5	0	0	2	12	0	1	0	0	1	0	3	0	3	21	38.18
1985	0	0	1	4	5	3	0.5	1	2	2	1	0.5	0	0	2	12	0	1	0	0	1	0	3	0	3	21	38.18
1986	0	0	1	4	5	3	0.5	1	2	2	1	0.5	0	0	2	12	0	1	0	0	1	0	3	0	3	21	38.18
1987	0	0	1	4	5	3	0.5	1	2	2	1	0.5	0	0	2	12	0	1	0	0	1	0	3	0	3	21	38.18
1988	0	0	1	4	5	3	0.5	1	2	2	1	0.5	0	0	2	12	0	1	0	0	1	0	3	0	3	21	38.18
1989	0	0	1	4	5	3	0.5	1	2	2	1	0.5	0	0	2	12	0	1	0	0	1	0	3	0	3	21	38.18
1990	0	0	1	4	5	3	0.5	1	2	2	1	0.5	0	0	2	12	0	1	0	0	1	0	3	0	3	21	38.18
1991	0	0	1	4	5	3	0.5	1	2	2	1	0.5	0	0	2	12	0	1	0	0	1	0	3	0	3	21	38.18
1992	0	0	1	4	5	3	0.5	1	2	2	1	0.5	0	0	2	12	2	1	1	0	4	0	3	0	3	24	43.64
1993	0	0	1	4	5	3	0.5	1	2	2	1	0.5	0	0	2	12	2	1	1	0	4	0	3	0	3	24	43.64
1994	0	0	1	6	7	3	0.5	1	2	2	1	0.5	0	0	2	12	2	1	1	0	4	0	3	0	3	26	47.27
1995	0	0	1	6	7	3	0.5	1	2	2	1	0.5	0	0	2	12	2	1	1	0	4	0	3	0	3	26	47.27
1996	0	0	1	6	7	3	0.5	1	2	2	1	0.5	0	0	2	12	2	1	1	0	4	0	3	0	3	26	47.27
1997	0	0	1	6	7	3	0.5	1	2	2	1	0.5	0	0	2	12	2	1	1	0	4	0	3	0	3	26	47.27
1998	0	0	1	6	7	3	0.5	1	2	2	1	0.5	0	0	2	12	2	1	1	0	4	0	3	0	3	26	47.27
1999	0	1	1	6	8	3	0.5	1	2	2	1	0.5	0	0	2	12	2	1	1	0	4	0	3	0	3	27	49.09
2000	4	1	1	6	12	3	0.5	1	2	2	1	0.5	0	0	2	12	2	1	1	0	4	0	3	0	3	31	56.36
2001	4	1	1	6	12	3	0.5	1	2	2	1	0.5	0	0	2	12	2	1	1	0	4	0	3	0	3	31	56.36
2002	4	1	1	6	12	3	0.5	1	2	2	1	0.5	0	0	2	12	2	1	1	0	4	2	4	0	6	34	61.82
2003	4	1	1	6	12	3	0.5	1	2	2	1	0.5	0	0	2	12	2	4	1	0	7	2	4	0	6	37	67.27
2004	4	1	1	6	12	3	0.5	1	2	2	1	0.5	0	0	2	12	2	4	1	0	7	2	4	0	6	37	67.27
2005	4	1	1	6	12	3	0.5	1	2	2	1	0.5	0.5	0	2	13	2	4	1	0	7	2	4	0	6	38	68.18
2006	4	1	1	6	12	3	0.5	1	2	2	1	0.5	0.5	0	2	13	2	4	1	0	7	2	4	0	6	38	68.18
2007	4	1	1	6	12	3	0.5	1	2	2	1	0.5	0.5	0	2	13	2	4	1	0	7	2	4	0	6	38	68.18
2008	4	1	1	6	12	3	0.5	1	2	2	1	0.5	0.5	0.5	2	13	2	4	1	0	7	2	4	0	6	38	69.09
2009	6	2	1	8	17	3	0.5	1	2	2	1	0.5	0.5	0.5	2	13	2	4	1	0	7	2	4	0	6	43	78.18
2010	6	2	1	8	17	3	0.5	1	2	2	1	0.5	0.5	0.5	2	13	2	4	1	0	7	2	4	0	6	43	78.18

Table 6. France – Annual scores and sub-scores for each of the four tobacco control policies

	Smokefree public places					Bans on tobacco advertising											Health Warnings					Tobacco Cessation Treatment				Total	
Year	a.	b.	c.	d.	Total	a.	b.	c.	d.	e.	f.	g.	h.	i.	j.	Total	a.	b.	c.	d.	Total	a.	b.	c.	Total	Total TCS Score	TCS Index Re-based
1950	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
1975	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	1	1.82
1976	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	1	2	3.64
1977	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	1	2	3.64
1978	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	1	2	3.64
1979	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	1	2	3.64
1980	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	1	2	3.64
1981	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	1	2	3.64
1982	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	1	2	3.64
1983	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	1	2	3.64
1984	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	1	2	3.64
1985	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	1	2	3.64
1986	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	1	2	3.64
1987	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	1	2	3.64
1988	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	1	2	3.64
1989	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	1	2	3.64
1990	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	1	0	1	2	3.64
1991	0	0	0	0	0	3	0.5	1	2	2	0	0.5	0.5	0	1	11	0	1	0	0	1	0	1	0	1	13	22.73
1992	2	1	1	2	6	3	0.5	1	2	2	0	0.5	0.5	0	1	11	0	1	0	0	1	0	1	0	1	19	33.64
1993	2	1	1	2	6	3	0.5	1	2	2	0	0.5	0.5	0	1	11	0	1	0	0	1	0	1	0	1	19	33.64
1994	2	1	1	2	6	3	0.5	1	2	2	0	0.5	0.5	0	1	11	0	1	0	0	1	0	1	0	1	19	33.64
1995	2	1	1	2	6	3	0.5	1	2	2	0	0.5	0.5	0	1	11	0	1	0	0	1	0	1	0	1	19	33.64
1996	2	1	1	2	6	3	0.5	1	2	2	0	0.5	0.5	0	1	11	0	1	0	0	1	0	1	0	1	19	33.64
1997	2	1	1	2	6	3	0.5	1	2	2	0	0.5	0.5	0	1	11	0	1	0	0	1	0	1	0	1	19	33.64
1998	2	1	1	2	6	3	0.5	1	2	2	0	0.5	0.5	0	1	11	0	1	0	0	1	0	1	0	1	19	33.64
1999	2	1	1	2	6	3	0.5	1	2	2	0	0.5	0.5	0	1	11	0	1	0	0	1	0	5	0	5	23	40.91
2000	2	1	1	2	6	3	0.5	1	2	2	0	0.5	0.5	0	1	11	0	1	0	0	1	0	5	0	5	23	40.91
2001	2	1	1	2	6	3	0.5	1	2	2	0	0.5	0.5	0	1	11	0	1	0	0	1	0	5	0	5	23	40.91
2002	2	1	1	2	6	3	0.5	1	2	2	0	0.5	0.5	0	1	11	0	1	0	0	1	0	5	0	5	23	40.91
2003	2	1	1	2	6	3	0.5	1	2	2	0	0.5	0.5	0	1	11	2	3	1	0	6	2	5	0	7	30	53.64
2004	2	1	1	2	6	3	0.5	1	2	2	0	0.5	0.5	0	1	11	2	3	1	0	6	2	5	0	7	30	53.64
2005	2	1	1	2	6	3	0.5	1	2	2	0	0.5	0.5	0	1	11	2	3	1	0	6	2	5	0	7	30	53.64
2006	2	1	1	2	6	3	0.5	1	2	2	0	0.5	0.5	0	1	11	2	3	1	0	6	2	5	0	7	30	53.64
2007	2	1	1	8	12	3	0.5	1	2	2	0	0.5	0.5	0	1	11	2	3	1	0	6	2	5	1	8	37	66.36
2008	6	2	1	8	17	3	0.5	1	2	2	0	0.5	0.5	0.5	1	11	2	3	1	0	6	2	5	1	8	42	76.36
2009	6	2	1	8	17	3	0.5	1	2	2	0	0.5	0.5	0.5	1	11	2	3	1	0	6	2	5	1	8	42	76.36
2010	6	2	1	8	17	3	0.5	1	2	2	0	0.5	0.5	0.5	1	11	2	3	1	0	6	2	5	1	8	42	76.36

Table 7. Germany – Annual scores and sub-scores for each of the four tobacco control policies

	Smokefree public places					Bans on tobacco advertising											Health Warnings					Tobacco Cessation Treatment				Total	
Year	a.	b.	c.	d.	Total	a.	b.	c.	d.	e.	f.	g.	h.	i.	j.	Total	a.	b.	c.	d.	Total	a.	b.	c.	Total	Total TCS Score	TCS Index Re-based
1950	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
1974	0	0	0	0	0	3	0.5	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	4	6.36
1975	0	0	0	0	0	3	0.5	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	4	6.36
1976	0	0	0	0	0	3	0.5	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	4	6.36
1977	0	0	0	0	0	3	0.5	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	4	6.36
1978	0	0	0	0	0	3	0.5	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	4	6.36
1979	0	0	0	0	0	3	0.5	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	4	6.36
1980	0	0	0	0	0	3	0.5	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	4	6.36
1981	0	0	0	0	0	3	0.5	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	4	6.36
1982	0	0	0	0	0	3	0.5	0	0	0	0	0	0	0	0	4	0	1	0	0	1	0	0	0	0	5	8.18
1983	0	0	0	0	0	3	0.5	0	0	0	0	0	0	0	0	4	0	1	0	0	1	0	0	0	0	5	8.18
1984	0	0	0	0	0	3	0.5	0	0	0	0	0	0	0	0	4	0	1	0	0	1	0	0	0	0	5	8.18
1985	0	0	0	0	0	3	0.5	0	0	0	0	0	0	0	0	4	0	1	0	0	1	0	0	0	0	5	8.18
1986	0	0	0	0	0	3	0.5	0	0	0	0	0	0	0	0	4	0	1	0	0	1	0	0	0	0	5	8.18
1987	0	0	0	0	0	3	0.5	0	0	0	0	0	0	0	0	4	0	1	0	0	1	0	0	0	0	5	8.18
1988	0	0	0	0	0	3	0.5	0	0	0	0	0	0	0	0	4	0	1	0	0	1	0	0	0	0	5	8.18
1989	0	0	0	0	0	3	0.5	0	0	0	0	0	0	0	0	4	0	1	0	0	1	0	0	0	0	5	8.18
1990	0	0	0	0	0	3	0.5	0	0	0	0	0	0	0	0	4	0	1	0	0	1	0	0	0	0	5	8.18
1991	0	0	0	0	0	3	0.5	0	0	0	0	0	0	0	0	4	2	1	1	0	4	0	0	0	0	8	13.64
1992	0	0	0	0	0	3	0.5	0	0	0	0	0	0	0	0	4	2	1	1	0	4	0	0	0	0	8	13.64
1993	0	0	0	0	0	3	0.5	0	0	0	0	0	0	0	0	4	2	1	1	0	4	0	0	0	0	8	13.64
1994	0	0	0	0	0	3	0.5	0	0	0	0	0	0	0	0	4	2	1	1	0	4	0	0	0	0	8	13.64
1995	0	0	0	0	0	3	0.5	0	0	0	0	0	0	0	0	4	2	1	1	0	4	0	0	0	0	8	13.64
1996	0	0	0	0	0	3	0.5	0	0	0	0	0	0	0	0	4	2	1	1	0	4	0	0	0	0	8	13.64
1997	0	0	0	0	0	3	0.5	0	0	0	0	0	0	0	0	4	2	1	1	0	4	0	0	0	0	8	13.64
1998	0	0	0	0	0	3	0.5	0	0	0	0	0	0	0	0	4	2	1	1	0	4	0	0	0	0	8	13.64
1999	0	0	0	0	0	3	0.5	0	0	0	0	0	0	0	0	4	2	1	1	0	4	2	1	0	3	11	19.09
2000	0	0	0	0	0	3	0.5	0	0	0	0	0	0	0	0	4	2	1	1	0	4	2	1	0	3	11	19.09
2001	0	0	0	0	0	3	0.5	0	0	0	0	0	0	0	0	4	2	1	1	0	4	2	1	0	3	11	19.09
2002	0	0	0	2	2	3	0.5	0	0	0	0	0	0	0	0	4	2	1	1	0	4	2	1	0	3	13	22.73
2003	0	0	0	2	2	3	0.5	0	0	0	0	0	0	0	0	4	2	3	1	0	6	2	1	0	3	15	26.36
2004	0	0	0	2	2	3	0.5	0	0	0	0	0	0	0	0	4	2	3	1	0	6	2	1	0	3	15	26.36
2005	0	0	0	2	2	3	0.5	0	0	0	0	0	0	0	0	4	2	3	1	0	6	2	1	0	3	15	26.36
2006	0	0	0	2	2	3	0.5	0	0	0	0	0	0.5	0	0	4	2	3	1	0	6	2	1	0	3	15	27.27
2007	4	2	1	4	11	3	0.5	0	0	0	0	0	0.5	0.5	0	5	2	3	1	0	6	2	2	0	4	26	46.36
2008	4	2	1	4	11	3	0.5	0	0	2	0	0	0.5	0.5	0	7	2	3	1	0	6	2	2	0	4	28	50.00
2009	4	2	1	4	11	3	0.5	0	0	2	0	0	0.5	0.5	0	7	2	3	1	0	6	2	2	0	4	28	50.00
2010	4	2	1	4	11	3	0.5	0	0	2	0	0	0.5	0.5	0	7	2	3	1	0	6	2	2	0	4	28	50.00

Table 8. Ireland – Annual scores and sub-scores for each of the four tobacco control policies

	Smokefree public places					Bans on tobacco advertising											Health Warnings					Tobacco Cessation Treatment				Total	
Year	a.	b.	c.	d.	To-tal	a.	b.	c.	d.	e.	f.	g.	h.	i.	j.	To-tal	a.	b.	c.	d.	To-tal	a.	b.	c.	To-tal	Total TCS Score	TCS Index Re-based
1950	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
1971	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	5.45
1972	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	5.45
1973	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	5.45
1974	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	5.45
1975	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	5.45
1976	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	5.45
1977	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	5.45
1978	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	5.45
1979	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	5.45
1980	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	5.45
1981	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	5.45
1982	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	5.45
1983	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	5.45
1984	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	5.45
1985	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	5.45
1986	0	0	0	0	0	3	0.5	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	4	6.36
1987	0	0	0	0	0	3	0.5	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	4	6.36
1988	0	0	0	0	0	3	0.5	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	4	6.36
1989	0	0	0	0	0	3	0.5	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	4	6.36
1990	0	0	0	0	0	3	0.5	0	0	0	0	0	0	0	0	4	0	0	0	0	0	0	0	0	0	4	6.36
1991	0	0	0	0	0	3	0.5	0	0	0	0	0	0	0	0	4	2	1	1	0	4	0	0	0	0	8	13.64
1992	0	0	0	0	0	3	0.5	0	0	0	0	0	0	0	0	4	2	1	1	0	4	0	3	0	3	11	19.09
1993	0	0	0	0	0	3	0.5	0	0	0	0	0	0	0	0	4	2	1	1	0	4	0	3	0	3	11	19.09
1994	0	0	0	0	0	3	0.5	0	0	0	0	0	0	0	0	4	2	1	1	0	4	0	3	0	3	11	19.09
1995	0	2	1	0	3	3	0.5	0	0	0	0	0	0	0	0	4	2	1	1	0	4	0	3	0	3	14	24.55
1996	0	2	1	0	3	3	0.5	0	0	0	0	0	0	0	0	4	2	1	1	0	4	0	3	0	3	14	24.55
1997	0	2	1	0	3	3	0.5	0	0	0	0	0	0	0	0	4	2	1	1	0	4	0	3	0	3	14	24.55
1998	0	2	1	0	3	3	0.5	0	0	0	0	0	0	0	0	4	2	1	1	0	4	0	3	0	3	14	24.55
1999	0	2	1	0	3	3	0.5	0	0	0	0	0	0	0	0	4	2	1	1	0	4	1	3	0	4	15	26.36
2000	0	2	1	0	3	3	0.5	0	0	0	0	0	0	0	0	4	2	1	1	0	4	1	4	0	5	16	28.18
2001	0	2	1	0	3	3	0.5	0	0	0	0	0	0	0	0	4	2	1	1	0	4	1	4	1	6	17	30.00
2002	0	2	1	0	3	3	0.5	0	0	0	0	0.5	0	0	0	4	2	1	1	0	4	1	5	1	7	18	32.73
2003	0	2	1	0	3	3	0.5	0	0	0	0	0.5	0	0	0	4	2	4	1	0	7	2	5	1	8	22	40.00
2004	8	2	1	10	21	3	0.5	1	2	2	0	0.5	0	0	0	9	2	4	1	0	7	2	5	1	8	45	81.82
2005	8	2	1	10	21	3	0.5	1	2	2	0	0.5	0.5	0	2	12	2	4	1	0	7	2	5	1	8	48	86.36
2006	8	2	1	10	21	3	0.5	1	2	2	0	0.5	0.5	0	2	12	2	4	1	0	7	2	5	1	8	48	86.36
2007	8	2	1	10	21	3	0.5	1	2	2	0	0.5	0.5	0	2	12	2	4	1	0	7	2	5	1	8	48	86.36
2008	8	2	1	10	21	3	0.5	1	2	2	0	0.5	0.5	0.5	2	12	2	4	1	0	7	2	5	1	8	48	87.27
2009	8	2	1	10	21	3	0.5	1	2	2	1	0.5	0.5	0.5	2	13	2	4	1	0	7	2	5	1	8	49	89.09
2010	8	2	1	10	21	3	0.5	1	2	2	1	0.5	0.5	0.5	2	13	2	4	1	0	7	2	5	1	8	49	89.09

Table 9. Italy – Annual scores and sub-scores for each of the four tobacco control policies

	Smokefree public places					Bans on tobacco advertising											Health Warnings					Tobacco Cessation Treatment				Total	
Year	a.	b.	c.	d.	Total	a.	b.	c.	d.	e.	f.	g.	h.	i.	j.	Total	a.	b.	c.	d.	Total	a.	b.	c.	Total	Total TCS Score	TCS Index Re-based
1950	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
1975	0	1	1	2	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	7.27
1976	0	1	1	2	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	7.27
1977	0	1	1	2	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	7.27
1978	0	1	1	2	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	7.27
1979	0	1	1	2	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	7.27
1980	0	1	1	2	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	7.27
1981	0	1	1	2	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	7.27
1982	0	1	1	2	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	7.27
1983	0	1	1	2	4	3	0.5	1	2	2	1	0	0	0	0	10	0	0	0	0	0	0	0	0	0	14	24.55
1984	0	1	1	2	4	3	0.5	1	2	2	1	0	0	0	0	10	0	0	0	0	0	0	3	0	3	17	30.00
1985	0	1	1	2	4	3	0.5	1	2	2	1	0	0	0	0	10	0	0	0	0	0	0	3	0	3	17	30.00
1986	0	1	1	2	4	3	0.5	1	2	2	1	0	0	0	0	10	0	0	0	0	0	0	3	0	3	17	30.00
1987	0	1	1	2	4	3	0.5	1	2	2	1	0	0	0	0	10	0	0	0	0	0	0	3	0	3	17	30.00
1988	0	1	1	2	4	3	0.5	1	2	2	1	0	0	0	0	10	0	0	0	0	0	0	3	0	3	17	30.00
1989	0	1	1	2	4	3	0.5	1	2	2	1	0	0	0	0	10	0	0	0	0	0	0	3	0	3	17	30.00
1990	0	1	1	2	4	3	0.5	1	2	2	1	0	0	0	0	10	0	0	0	0	0	0	3	0	3	17	30.00
1991	0	1	1	2	4	3	0.5	1	2	2	1	0	0	0	2	12	0	0	0	0	0	0	3	0	3	19	33.64
1992	0	1	1	2	4	3	0.5	1	2	2	1	0	0	0	2	12	0	0	0	0	0	0	3	0	3	19	33.64
1993	0	1	1	2	4	3	0.5	1	2	2	1	0	0	0	2	12	2	1	1	0	4	0	3	0	3	23	40.91
1994	0	1	1	2	4	3	0.5	1	2	2	1	0	0	0	2	12	2	1	1	0	4	0	3	0	3	23	40.91
1995	0	1	1	4	6	3	0.5	1	2	2	1	0	0	0	2	12	2	1	1	0	4	0	3	0	3	25	44.55
1996	0	1	1	4	6	3	0.5	1	2	2	1	0	0	0	2	12	2	1	1	0	4	0	3	0	3	25	44.55
1997	0	1	1	4	6	3	0.5	1	2	2	1	0	0	0	2	12	2	1	1	0	4	0	3	0	3	25	44.55
1998	0	1	1	4	6	3	0.5	1	2	2	1	0	0	0	2	12	2	1	1	0	4	0	3	0	3	25	44.55
1999	0	1	1	4	6	3	0.5	1	2	2	1	0	0	0	2	12	2	1	1	0	4	2	3	0	5	27	48.18
2000	0	1	1	4	6	3	0.5	1	2	2	1	0	0	0	2	12	2	1	1	0	4	2	3	0	5	27	48.18
2001	0	1	1	4	6	3	0.5	1	2	2	1	0	0	0	2	12	2	1	1	0	4	2	3	0	5	27	48.18
2002	0	1	1	4	6	3	0.5	1	2	2	1	0	0	0	2	12	2	1	1	0	4	2	4	0	6	28	50.00
2003	0	1	1	4	6	3	0.5	1	2	2	1	0	0	0	2	12	2	3	1	0	6	2	4	0	6	30	53.64
2004	0	1	1	4	6	3	0.5	1	2	2	1	0	0	0	2	12	2	3	1	0	6	2	4	0	6	30	53.64
2005	6	2	1	8	17	3	0.5	1	2	2	1	0.5	0.5	0	2	13	2	3	1	0	6	2	4	0	6	42	75.45
2006	6	2	1	8	17	3	0.5	1	2	2	1	0.5	0.5	0	2	13	2	3	1	0	6	2	4	0	6	42	75.45
2007	6	2	1	8	17	3	0.5	1	2	2	1	0.5	0.5	0	2	13	2	3	1	0	6	2	4	0	6	42	75.45
2008	6	2	1	8	17	3	0.5	1	2	2	1	0.5	0.5	0	2	13	2	3	1	0	6	2	4	0	6	42	75.45
2009	6	2	1	8	17	3	0.5	1	2	2	1	0.5	0.5	0	2	13	2	3	1	0	6	2	4	0	6	42	75.45
2010	6	2	1	8	17	3	0.5	1	2	2	1	0.5	0.5	0	2	13	2	3	1	0	6	2	4	0	6	42	75.45

Table 10. Netherlands – Annual scores and sub-scores for each of the four tobacco control policies

	Smokefree public places					Bans on tobacco advertising											Health Warnings					Tobacco Cessation Treatment				Total	
Year	a.	b.	c.	d.	Total	a.	b.	c.	d.	e.	f.	g.	h.	i.	j.	Total	a.	b.	c.	d.	Total	a.	b.	c.	Total	Total TCS Score	TCS Index Re-based
1950	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
1990	0	0	1	0	1	3	0.5	0	0	0	0	0	0	0	0	4	2	1	1	0	4	0	0	0	0	9	15.45
1991	0	0	1	0	1	3	0.5	0	0	0	0	0	0	0	0	4	2	1	1	0	4	0	0	0	0	9	15.45
1992	0	0	1	0	1	3	0.5	0	0	0	0	0	0	0	0	4	2	1	1	0	4	0	0	0	0	9	15.45
1993	0	0	1	0	1	3	0.5	0	0	0	0	0	0	0	0	4	2	1	1	0	4	0	0	0	0	9	15.45
1994	0	0	1	0	1	3	0.5	0	0	0	0	0	0	0	0	4	2	1	1	0	4	0	0	0	0	9	15.45
1995	0	0	1	0	1	3	0.5	0	0	0	0	0	0	0	0	4	2	1	1	0	4	0	0	0	0	9	15.45
1996	0	0	1	0	1	3	0.5	1	0	0	0	0	0	0	0	5	2	1	1	0	4	0	5	0	5	15	26.36
1997	0	0	1	0	1	3	0.5	1	0	0	0	0	0	0	0	5	2	1	1	0	4	0	5	0	5	15	26.36
1998	0	0	1	0	1	3	0.5	1	0	0	0	0	0	0	0	5	2	1	1	0	4	0	5	0	5	15	26.36
1999	0	0	1	0	1	3	0.5	1	0	0	0	0	0	0	0	5	2	1	1	0	4	0	5	0	5	15	26.36
2000	0	0	1	0	1	3	0.5	1	0	0	0	0	0	0	0	5	2	1	1	0	4	2	5	0	7	17	30.00
2001	0	0	1	0	1	3	0.5	1	0	0	0	0	0	0	0	5	2	1	1	0	4	2	5	0	7	17	30.00
2002	0	0	1	0	1	3	0.5	1	2	0	0	0.5	0	0	2	9	2	3	1	0	6	2	5	0	7	23	41.82
2003	0	0	1	0	1	3	0.5	1	2	2	0	0.5	0	0	2	11	2	3	1	0	6	2	5	0	7	25	45.45
2004	0	2	1	6	9	3	0.5	1	2	2	0	0.5	0	0	2	11	2	3	1	0	6	2	5	0	7	33	60.00
2005	0	2	1	6	9	3	0.5	1	2	2	0	0.5	0	0.5	2	12	2	3	1	0	6	2	5	0	7	34	60.91
2006	0	2	1	6	9	3	0.5	1	2	2	0	0.5	0	0.5	2	12	2	3	1	0	6	2	5	0	7	34	60.91
2007	0	2	1	6	9	3	0.5	1	2	2	0	0.5	0	0.5	2	12	2	3	1	0	6	2	5	0	7	34	60.91
2008	4	2	1	6	13	3	0.5	1	2	2	0	0.5	0.5	0.5	2	12	2	3	1	0	6	2	5	0	7	38	69.09
2009	4	2	1	6	13	3	0.5	1	2	2	0	0.5	0.5	0.5	2	12	2	3	1	0	6	2	5	0	7	38	69.09
2010	4	2	1	6	13	3	0.5	1	2	2	0	0.5	0.5	0.5	2	12	2	3	1	0	6	2	5	0	7	38	69.09

Table 11. Portugal – Annual scores and sub-scores for each of the four tobacco control policies

	Smokefree public places					Bans on tobacco advertising											Health Warnings					Tobacco Cessation Treatment				Total	
Year	a.	b.	c.	d.	**Total**	a.	b.	c.	d.	e.	f.	g.	h.	i.	j.	**Total**	a.	b.	c.	d.	**Total**	a.	b.	c.	**Total**	**Total TCS Score**	**TCS Index Re-based**
1950	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
1983	0	1	1	2	4	3	0.5	1	2	2	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	13	22.73
1984	0	1	1	2	4	3	0.5	1	2	2	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	13	22.73
1985	0	1	1	2	4	3	0.5	1	2	2	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	13	22.73
1986	0	1	1	2	4	3	0.5	1	2	2	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	13	22.73
1987	0	1	1	2	4	3	0.5	1	2	2	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	13	22.73
1988	0	1	1	2	4	3	0.5	1	2	2	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	13	22.73
1989	0	1	1	2	4	3	0.5	1	2	2	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	13	22.73
1990	0	1	1	2	4	3	0.5	1	2	2	0	0	0	0	0	9	0	0	0	0	0	0	0	0	0	13	22.73
1991	0	1	1	2	4	3	0.5	1	2	2	0	0	0	0	0	9	2	1	1	0	4	0	0	0	0	17	30.00
1992	0	1	1	2	4	3	0.5	1	2	2	0	0	0	0	0	9	2	1	1	0	4	0	0	0	0	17	30.00
1993	0	1	1	2	4	3	0.5	1	2	2	0	0	0	0	0	9	2	1	1	0	4	0	0	0	0	17	30.00
1994	0	1	1	2	4	3	0.5	1	2	2	0	0	0	0	0	9	2	1	1	0	4	0	0	0	0	17	30.00
1995	0	1	1	2	4	3	0.5	1	2	2	0	0	0	0	0	9	2	1	1	0	4	0	0	0	0	17	30.00
1996	0	1	1	2	4	3	0.5	1	2	2	0	0.5	0	0	0	9	2	1	1	0	4	0	0	0	0	17	30.91
1997	0	1	1	2	4	3	0.5	1	2	2	0	0.5	0	0	0	9	2	1	1	0	4	0	0	0	0	17	30.91
1998	0	1	1	2	4	3	0.5	1	2	2	0	0.5	0	0	0	9	2	1	1	0	4	0	0	0	0	17	30.91
1999	0	1	1	2	4	3	0.5	1	2	2	0	0.5	0	0	0	9	2	1	1	0	4	0	0	0	0	17	30.91
2000	0	1	1	2	4	3	0.5	1	2	2	0	0.5	0	0	0	9	2	1	1	0	4	0	0	0	0	17	30.91
2001	0	1	1	2	4	3	0.5	1	2	2	0	0.5	0	0	0	9	2	1	1	0	4	0	0	0	0	17	30.91
2002	0	1	1	2	4	3	0.5	1	2	2	0	0.5	0	0	0	9	2	1	1	0	4	2	0	0	2	19	34.55
2003	0	1	1	2	4	3	0.5	1	2	2	0	0.5	0	0	0	9	2	3	1	0	6	2	0	0	2	21	38.18
2004	0	1	1	2	4	3	0.5	1	2	2	0	0.5	0	0	0	9	2	3	1	0	6	2	0	0	2	21	38.18
2005	0	1	1	2	4	3	0.5	1	2	2	0	0.5	0	0.5	0	10	2	3	1	0	6	2	4	0	6	26	46.36
2006	0	1	1	2	4	3	0.5	1	2	2	0	0.5	0	0.5	0	10	2	3	1	0	6	2	4	0	6	26	46.36
2007	0	1	1	2	4	3	0.5	1	2	2	0	0.5	0	0.5	0	10	2	3	1	0	6	2	4	0	6	26	46.36
2008	4	2	1	4	11	3	0.5	1	2	2	0	0.5	0.5	0.5	0	10	2	3	1	0	6	2	5	0	7	34	61.82
2009	4	2	1	4	11	3	0.5	1	2	2	0	0.5	0.5	0.5	0	10	2	3	1	0	6	2	5	0	7	34	61.82
2010	4	2	1	4	11	3	0.5	1	2	2	0	0.5	0.5	0.5	0	10	2	3	1	0	6	2	5	0	7	34	61.82

Table 12. Spain – Annual scores and sub-scores for each of the four tobacco control policies

	Smokefree public places					Bans on tobacco advertising											Health Warnings					Tobacco Cessation Treatment				Total	
Year	a.	b.	c.	d.	**Total**	a.	b.	c.	d.	e.	f.	g.	h.	i.	j.	**Total**	a.	b.	c.	d.	**Total**	a.	b.	c.	**Total**	**Total TCS Score**	**TCS Index Re-based**
1950	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
1988	0	2	1	2	5	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	6	10.91
1989	0	2	1	2	5	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	6	10.91
1990	0	2	1	2	5	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	0	6	10.91
1991	0	2	1	2	5	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	2	0	5	0	5	12	21.82
1992	0	2	1	2	5	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0	4	0	5	0	5	14	25.45
1993	0	2	1	2	5	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0	4	0	5	0	5	14	25.45
1994	0	2	1	2	5	3	0.5	0	0	0	0	0	0	0	0	4	2	1	1	0	4	0	5	0	5	18	31.82
1995	0	2	1	2	5	3	0.5	0	0	0	0	0	0	0	0	4	2	1	1	0	4	0	5	0	5	18	31.82
1996	0	2	1	2	5	3	0.5	0	0	0	0	0	0	0	0	4	2	1	1	0	4	0	6	0	6	19	33.64
1997	0	2	1	2	5	3	0.5	0	0	0	0	0	0	0	0	4	2	1	1	0	4	0	6	0	6	19	33.64
1998	0	2	1	2	5	3	0.5	0	0	0	0	0	0	0	0	4	2	1	1	0	4	0	6	0	6	19	33.64
1999	0	2	1	2	5	3	0.5	0	0	0	0	0	0	0	0	4	2	1	1	0	4	0	6	0	6	19	33.64
2000	0	2	1	2	5	3	0.5	0	0	0	0	0	0	0	0	4	2	1	1	0	4	0	6	0	6	19	33.64
2001	0	2	1	2	5	3	0.5	0	0	0	0	0	0	0	0	4	2	1	1	0	4	1	6	0	7	20	35.45
2002	0	2	1	2	5	3	0.5	0	0	0	0	0	0	0	0	4	2	3	1	0	6	1	6	0	7	22	39.09
2003	0	2	1	2	5	3	0.5	0	0	0	0	0	0	0	0	4	2	3	1	0	6	1	6	0	7	22	39.09
2004	0	2	1	2	5	3	0.5	0	0	0	0	0	0	0	0	4	2	3	1	0	6	1	6	0	7	22	39.09
2005	0	2	1	2	5	3	0.5	0	0	0	0	0	0	0	0	4	2	3	1	0	6	1	6	0	7	22	39.09
2006	2	2	1	10	15	3	0.5	1	2	2	1	0.5	0.5	0	2	13	2	3	1	0	6	1	6	0	7	41	73.64
2007	2	2	1	10	15	3	0.5	1	2	2	1	0.5	0.5	0	2	13	2	3	1	0	6	1	6	0	7	41	73.64
2008	2	2	1	10	15	3	0.5	1	2	2	1	0.5	0.5	0.5	2	13	2	3	1	0	6	1	6	0	7	41	74.55
2009	2	2	1	10	15	3	0.5	1	2	2	1	0.5	0.5	0.5	2	13	2	3	1	0	6	1	6	0	7	41	74.55
2010	8	2	1	10	21	3	0.5	1	2	2	1	0.5	0.5	0.5	2	13	2	3	1	0	6	1	6	0	7	47	85.45

Table 13. Sweden – Annual scores and sub-scores for each of the four tobacco control policies

	Smokefree public places					Bans on tobacco advertising											Health Warnings					Tobacco Cessation Treatment				Total	
Year	a.	b.	c.	d.	Total	a.	b.	c.	d.	e.	f.	g.	h.	i.	j.	Total	a.	b.	c.	d.	Total	a.	b.	c.	Total	Total TCS Score	TCS Index Rebased
1950	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
1970	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	3	5.45
1971	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	3	5.45
1972	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	3	5.45
1973	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0	3	3	5.45
1974	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	3	0	3	4	7.27
1975	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	3	0	3	4	7.27
1976	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	3	0	3	4	7.27
1977	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	3	0	3	4	7.27
1978	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	3	0	3	4	7.27
1979	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	3	0	3	4	7.27
1980	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	3	0	3	4	7.27
1981	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	3	0	3	4	7.27
1982	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	3	0	3	4	7.27
1983	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	3	0	3	4	7.27
1984	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	3	0	3	4	7.27
1985	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	0	3	0	3	4	7.27
1986	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0	4	0	3	0	3	7	12.73
1987	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0	4	0	3	0	3	7	12.73
1988	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0	4	0	3	0	3	7	12.73
1989	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0	4	0	3	0	3	7	12.73
1990	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0	4	0	3	0	3	7	12.73
1991	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0	4	0	4	0	4	8	14.55
1992	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0	4	0	4	0	4	8	14.55
1993	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	1	1	0	4	0	4	0	4	8	14.55
1994	2	2	1	4	9	3	0.5	1	2	2	0	0.5	0	0	2	11	2	1	1	0	4	0	4	0	4	28	50.91
1995	2	2	1	4	9	3	0.5	1	2	2	0	0.5	0	0	2	11	2	1	1	0	4	0	4	0	4	28	50.91
1996	2	2	1	4	9	3	0.5	1	2	2	0	0.5	0	0	2	11	2	1	1	0	4	0	4	0	4	28	50.91
1997	2	2	1	4	9	3	0.5	1	2	2	0	0.5	0	0	2	11	2	1	1	0	4	0	4	0	4	28	50.91
1998	2	2	1	4	9	3	0.5	1	2	2	0	0.5	0	0	2	11	2	1	1	0	4	2	4	0	6	30	54.55
1999	2	2	1	4	9	3	0.5	1	2	2	0	0.5	0	0	2	11	2	1	1	0	4	2	4	0	6	30	54.55
2000	2	2	1	4	9	3	0.5	1	2	2	0	0.5	0	0	2	11	2	1	1	0	4	2	5	1	8	32	58.18
2001	2	2	1	4	9	3	0.5	1	2	2	0	0.5	0	0	2	11	2	1	1	0	4	2	5	1	8	32	58.18
2002	2	2	1	4	9	3	0.5	1	2	2	0	0.5	0	0	2	11	2	1	1	0	4	2	5	1	8	32	58.18
2003	2	2	1	4	9	3	0.5	1	2	2	0	0.5	0	0	2	11	2	3	1	0	6	2	5	1	8	34	61.82
2004	2	2	1	4	9	3	0.5	1	2	2	0	0.5	0	0	2	11	2	3	1	0	6	2	5	1	8	34	61.82
2005	6	2	1	6	15	3	0.5	1	2	2	1	0.5	0.5	0	2	13	2	3	1	0	6	2	5	1	8	42	75.45
2006	6	2	1	6	15	3	0.5	1	2	2	1	0.5	0.5	0	2	13	2	3	1	0	6	2	5	1	8	42	75.45
2007	6	2	1	6	15	3	0.5	1	2	2	1	0.5	0.5	0	2	13	2	3	1	0	6	2	5	1	8	42	75.45
2008	6	2	1	6	15	3	0.5	1	2	2	1	0.5	0.5	0.5	2	13	2	3	1	0	6	2	5	1	8	42	76.36
2009	6	2	1	6	15	3	0.5	1	2	2	1	0.5	0.5	0.5	2	13	2	3	1	0	6	2	5	1	8	42	76.36
2010	6	2	1	6	15	3	0.5	1	2	2	1	0.5	0.5	0.5	2	13	2	3	1	0	6	2	5	1	8	42	76.36

Table 14. United Kingdom – Annual scores and sub-scores for each of the four tobacco control policies

	Smokefree public places					Bans on tobacco advertising											Health Warnings					Tobacco Cessation Treatment				Total	
Year	a.	b.	c.	d.	Total	a.	b.	c.	d.	e.	f.	g.	h.	i.	j.	Total	a.	b.	c.	d.	Total	a.	b.	c.	Total	Total TCS Score	TCS Index Re-based
1950	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
...	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.00
1987	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	2	3.64
1988	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	2	3.64
1989	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	0	2	2	3.64
1990	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0	2	0	0	2	5	9.09
1991	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	2	1	1	0	4	2	0	0	2	9	16.36
1992	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	2	1	1	0	4	2	4	0	6	13	23.64
1993	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	2	1	1	0	4	2	4	0	6	13	23.64
1994	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	2	1	1	0	4	2	4	0	6	13	23.64
1995	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	2	1	1	0	4	2	4	0	6	13	23.64
1996	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	2	1	1	0	4	2	4	0	6	13	23.64
1997	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	2	1	1	0	4	2	4	0	6	13	23.64
1998	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	2	1	1	0	4	2	4	0	6	13	23.64
1999	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	2	1	1	0	4	2	6	0	8	15	27.27
2000	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	2	1	1	0	4	2	6	0	8	15	27.27
2001	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	2	1	1	0	4	2	6	2	10	17	30.91
2002	0	0	0	0	0	3	0	0	0	0	0	0	0	0	0	3	2	1	1	0	4	2	6	2	10	17	30.91
2003	0	0	0	0	0	3	0.5	1	2	2	0	0	0	0.5	0	9	2	3	1	0	6	2	6	2	10	25	45.45
2004	0	0	0	0	0	3	0.5	1	2	2	0	0	0	0.5	0	9	2	3	1	0	6	2	6	2	10	25	45.45
2005	0	1	0	0	1	3	0.5	1	2	2	0	0.5	0.5	0.5	2	12	2	3	1	0	6	2	6	2	10	29	52.73
2006	4	1	1	4	10	3	0.5	1	2	2	0	0.5	0.5	0.5	2	12	2	3	1	0	6	2	6	2	10	38	69.09
2007	8	2	1	10	21	3	0.5	1	2	2	0	0.5	0.5	0.5	2	12	2	3	1	0	6	2	6	2	10	49	89.09
2008	8	2	1	10	21	3	0.5	1	2	2	0	0.5	0.5	0.5	2	12	2	3	1	3	9	2	6	2	10	52	94.55
2009	8	2	1	10	21	3	0.5	1	2	2	0	0.5	0.5	0.5	2	12	2	3	1	3	9	2	6	2	10	52	94.55
2010	8	2	1	10	21	3	0.5	1	2	2	0	0.5	0.5	0.5	2	12	2	3	1	3	9	2	6	2	10	52	94.55

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Appendix B.

The Tobacco Control Scale (TCS) policy scoring system

Description of Policy Measure	Total TCS Score (max 55)	Rebased TCS Scores (max 100)
Smoking free work and other public places	**22**	**40.00**
a. Cafes and restaurants – one only of:	8	14.55
Complete ban, enforced	8	14.55
Complete ban, but with closed, ventilated, designated smoking rooms; enforced	6	10.91
Meaningful restrictions; enforced	4	7.27
Legislation, but not enforced	2	3.64
b. Public transport – additive	2	3.64
Complete ban in domestic trains without exceptions	1	1.82
Complete ban in other public transport without exceptions	1	1.82
c. Other public places	2	3.64
Complete ban in educational, health, government and cultural places, without exception OR	2	3.64
Ban in education, health, government and cultural places, but with designated smoking areas or rooms	1	1.82
d. Workplaces excluding cafes and restaurants – one only of:	10	18.18
Complete ban without exceptions (no smoking rooms); enforced	10	18.18
Complete ban, but with closed, ventilated, designated smoking rooms; enforced	8	14.55
Complete ban, but with ventilated, designated smoking rooms; enforced	6	10.91
Meaningful restrictions; enforced	4	7.27
Legislation, but not enforced	2	3.64
Comprehensive bans on advertising and promotion on July 1st of the year	**13**	**23.64**
Points for each type of ban – additive		
a. Complete ban on tobacco advertising on television	3	5.45
b. Complete ban on outdoor advertising (e.g. posters)	2	3.64
c. Complete ban on advertising in print media (e.g. newspapers and magazines)	2	3.64
d. Complete ban on indirect advertising (e.g. cigarette branded clothes, watches etc)	2	3.64
e. Ban on point of sale advertising	1	1.82
f. Ban on cinema advertising	1	1.82
g. Ban on sponsorship	1	1.82
h. Ban on internet advertising	0.5	0.91
i. Ban on radio advertising	0.5	0.91

Appendix B. *Continued*

Description of Policy Measure	Total TCS Score (max 55)	Rebased TCS Scores (max 100)
Large direct health warning labels on July 1st of the year	**10**	**18.18**
a. Rotating health warnings	2	3.64
b. Size of warning – one only of:	4	7.27
10% or less of packet	1	1.82
11–25% of packet	2	3.64
26–40% of packet	3	5.45
41% or more of packet	4	7.27
c. Contrasting colour (e.g. Black lettering on white background)	1	1.82
d. A picture or graphic image	3	5.45
Treatment to help dependent smokers stop	**10**	**18.18**
a. Quitline – one only of:	2	3.64
Well-funded national quitline or well-funded quitlines in all major regions of country	2	3.64
National quitline with limited funding or a patchwork of small local quitlines	1	1.82
b. Network of smoking cessation support (3) and reimbursement of treatment (3)	6	10.91
Cessation support network covering whole country (3), free (3)	6	10.91
Cessation support network, but only in selected areas (e.g. major cities) (2); free (3)	5	9.09
Cessation support network covering whole country (3), cost partially covered (2)	5	9.09
Cessation support network, but very limited, just a few centres (1), free (3)	4	7.27
Cessation support network, but only in selected areas (e.g. major cities) (2), costs partially covered (2)	4	7.27
Cessation support network covering whole country (3), not free (0)	3	5.45
Cessation support network, but very limited, just a few centres (1), costs partially covered (2)	3	5.45
Cessation support network, but only in selected areas (e.g. major cities) (2), not free (0)	2	3.64
Cessation support network, just a few centres (1), not free (0)	1	1.82
c. Reimbursement of medications – one only of:	2	3.64
Reimbursement of pharmaceutical treatment products	2	3.64
Partial reimbursement of pharmaceutical treatment products	1	1.82
Total score	55	100.00

Source: Adapted from Joossens and Raw (2006). See Appendix A.

Appendix C.

Variables specified for tobacco control policies implemented

As an alternative approach to the tobacco control policy index variable, we can use dummy and trend variables to specify actions against smoking. This appendix introduces dummy and trend variables specified for the tobacco control policies implemented in the 11 countries. These variables can be used traditionally as explanatory variables in the empirical models in country-specific analyses to study the impact of tobacco control policies on tobacco consumption.

Country and period	Description	Variable specification
Tobacco Control Policies		
Austria 1976–2009		
	Tobacco control policy data have not been available	
Finland 1960–2009		
1964	Health education	= 1 for 1964; 0 otherwise
1976	Comprehensive Tobacco Law (incl. e.g. smoking ban in public sites)	= 1 for 1976 onwards; 0 otherwise
1995	Smoking ban in work places	= 1 for 1995 onwards; 0 otherwise
2000	Smoking restrictions in restaurants and bars	= 1 for 2000 onwards; 0 otherwise
2008	Smoking ban in restaurants and bars	= 1 for 2008 onwards; 0 otherwise
France 1950–2009		
1976	Restriction of public tobacco advertising	= 1 for 1976; 0 otherwise
1992	Smoking restrictions in public places, work places, restaurants and bars. Total prohibition of tobacco advertising in the press	= 1 for 1992 onwards; 0 otherwise
2007	Smoking ban in public places	= 1 for 2007 onwards; 0 otherwise
2008	Smoking ban in restaurants and bars	= 1 for 2008 onwards; 0 otherwise
Germany 1960–2009		
1975	Advertising ban for TV and radio	= 1 for 1975; 0 otherwise
2003	Regulations on smoking in indoor work places	= 1 for 2003 onwards; 0 otherwise
2007	Advertising ban in print media and internet	= 1 for 2007 onwards; 0 otherwise
Ireland 1970–2009		
2004	National smoking cessation campaign and smoking ban	= 1 for 2004 onwards; 0 otherwise
Italy 1970–2009		
1992	Ban on television advertising of tobacco products	= 1 for 1992; 0 otherwise
2005	Smoking ban in public places	= 1 for 2005 onwards; 0 otherwise

Appendix C. *Continued*

Country and period	Description	Variable specification
Netherlands 1980–2009		
1990	Tobacco advertising ban	= 1 for 1990; 0 otherwise
2003	Ban on tobacco advertising and sponsorship	= 1 for 2003 onwards; 0 otherwise
2004	Smoking ban in work places and public transport	= 1 for 2004 onwards; 0 otherwise
2008	Smoking ban in hospitality, sport, and art/culture sector	= 1 for 2008; 0 otherwise
Portugal 1970–2009		
1981	Tobacco advertising ban (TV, radio, newspapers, points of sales, etc.)	= 1 for 1981 onwards; 0 otherwise
1982	Prohibition of smoking outside of designated smoking areas	= 1 for 1982 onwards; 0 otherwise
1990	Prohibition of smoking in establishments (restaurants, bakeries, breweries, etc.)	= 1 for 1990 onwards; 0 otherwise
Spain 1960–2009		
1989	Ban of tobacco consumption in public centres and transportations and some workplaces	= 1 for 1989 onwards; 0 otherwise
1995	Total ban of tobacco advertisement	= 1 for 1995; 0 otherwise
2006	Smoking ban in public places and transportation	= 1 for 2006 onwards; 0 otherwise
Sweden 1955–2009		
1960	Health education	= 1 for 1960; 0 otherwise
1964	Health education	= 1 for 1964; 0 otherwise
1979	Advertising restrictions	= 1 for 1979; 0 otherwise
1994	Smoking restriction in public places	= 1 for 1994 onwards; 0 otherwise
1995	Advertising ban	= 1 for 1995; 0 otherwise
2006	Smoking ban in restaurants and bars	= 1 for 2006 onwards; 0 otherwise
United Kingdom 1953–2009		
1962	First Report by Royal College of Physicians	= 1 for 1962 onwards; 0 otherwise
1971	Second Report by Royal College of Physicians	= 1 for 1971 onwards; 0 otherwise
1977	Third Report by Royal College of Physicians	= 1 for 1977 onwards; 0 otherwise
1983	Fourth Report by Royal College of Physicians	= 1 for 1983 onwards; 0 otherwise

Appendix C. *Continued*

Country and period	Description	Variable specification
1992	Prohibiting the supply of oral tobacco and the sale of tobacco products exceeding the maximum tar yields. National Health Service Regulations	= 1 for 1992 onwards; 0 otherwise
2003	Restrictions on tobacco product advertising and promotion	= 1 for 2003 onwards; 0 otherwise
2007	Smoking ban in public places and work places	= 1 for 2007 onwards; 0 otherwise
Trend variables		
Finland 1960–2009		
R1976	Relapse rate	= 1, 2, …, 15 for 1977 to 1991 = 0 otherwise
United Kingdom 1953–2009		
R1963	Relapse rate	= 0 prior to 1963 = 1, 2, …, 8 for 1963 to 1970 = 9 for 1971 onwards
R1972	Relapse rate	= 0 prior to 1972 = 1, 2, …, 5 for 1972 to 1976 = 6 for 1977 onwards
R1978	Relapse rate	= 0 prior to 1978 = 1, 2, …, 5 for 1978 to 1982 = 6 for 1983 onwards
R1984[#]	Relapse rate	= 0 prior to 1983 = 1, 2, …, 8 for 1984 to 1991 = 9 for 1992 onwards

[#] The variable will be used to replace the variable R1984 that was used in the models for the United Kingdom when the tobacco control scale index variable is not used in the empirical models as an explanatory variable. This variable specification is a little different from the previous variable R1984 because the variable captures health-related information like health scares for a longer period.

Appendices D1–D11.

Testing stationarity of time series

When testing the stationarity of the time series for each study country, the unit root tests were conducted with a constant term, a time trend and one lag. ADF means Augmented Dickey-Fuller. L stands for the level of the variable and D for its 1st difference.

Appendix D1. Testing the stationarity of the time series, Austria 1976–2009

Description	Specification	Testing stationarity	ADF test		Phillips-Perron test		Level of integration
			Statistic	p	Statistic	p	
ln (number of cigarettes)	$\ln(Q_{st})$	L	-2.36	0.404	-2.79	0.202	I(1)
		D	-4.56	0.001	-6.51	0.000	I(0)
ln (real price index of cigarettes)	$\ln(P_{st})$	L	-1.79	0.708	-1.44	0.848	I(1)
		D	-2.99	0.134	-5.29	0.000	I(1)/I(0)
ln (real disposable income)	$\ln(Y_t)$	L	-2.31	0.427	-1.95	0.631	I(1)
		D	-4.83	0.000	-4.10	0.006	I(0)
tobacco control scale	TCS_t	L	-0.64	0.977	-0.57	0.980	I(1)
		D	-4.56	0.001	-5.54	0.000	I(0)

Appendix D2. Testing the stationarity of the time series, Finland 1960–2009

Description	Specification	Testing stationarity	ADF test		Phillips-Perron test		Level of integration
			Statistic	p	Statistic	p	
ln (number of cigarettes)	$\ln(Q_{st})$[a]	L	-1.84	0.687	-1.91	0.652	I(1)
		D	-4.04	0.008	-6.33	0.000	I(0)
ln (quantity of pipe and hand-rolling tobacco)	$\ln(Q_{pt})$[b]	L	-3.69	0.023	-2.39	0.386	I(1)
		D	-5.08	0.000	-5.86	0.000	I(0)
ln (real price index of cigarettes)	$\ln(P_{st})$[a]	L	-2.30	0.434	-2.14	0.522	I(1)
		D	-5.16	0.000	-6.20	0.000	I(0)
ln (real price index of pipe and hand-rolling tobacco)	$\ln(P_{pt})$[b]	L	-1.98	0.611	-1.92	0.646	I(1)
		D	-5.46	0.000	-5.88	0.000	I(0)
ln (real disposable income)	$\ln(Y_t)$[a]	L	-1.93	0.637	-2.27	0.451	I(1)
		D	-4.74	0.001	-6.02	0.000	I(0)
tobacco control scale	TCS_t[a]	L	-2.59	0.283	-2.66	0.251	I(1)
		D	-4.96	0.000	-7.06	0.000	I(0)

[a] Using cigarette demand data 1960–2009.

[b] Using pipe and hand-rolling tobacco demand data 1960–2002.

Appendix D3. Testing the stationarity of the time series, France 1950–2009

Description	Specification	Testing stationarity	ADF test		Phillips-Perron test		Level of integration
			Statistic	p	Statistic	p	
ln (number of cigarettes)	$\ln(Q_{st})$	L	-0.40	0.987	-0.19	0.992	I(1)
		D	-5.54	0.000	-5.49	0.000	I(0)
ln (real price index of cigarettes)	$\ln(P_{st})$	L	-0.10	0.993	-0.20	0.992	I(1)
		D	-3.99	0.009	-6.73	0.000	I(0)
ln (real disposable income)	$\ln(Y_t)$	L	-1.85	0.682	-2.27	0.449	I(1)
		D	-4.75	0.001	-5.58	0.000	I(0)
tobacco control scale	TCS_t	L	0.17	0.996	0.18	0.996	I(1)
		D	-5.91	0.000	-7.57	0.000	I(0)

Appendix D4. Testing the stationarity of the time series, Germany 1960–2009

Description	Specification	Testing stationarity	ADF test		Phillips-Perron test		Level of integration
			Statistic	p	Statistic	p	
ln (number of cigarettes)	$\ln(Q_{st})$	L	-1.48	0.835	-1.81	0.701	I(1)
		D	-4.55	0.001	-7.35	0.000	I(0)
ln (quantity of pipe and hand-rolling tobacco)	$\ln(Q_{pt})$	L	-2.10	0.546	-2.17	0.509	I(1)
		D	-5.37	0.000	-6.84	0.000	I(0)
ln (real price index of cigarettes)	$\ln(P_{st})$	L	-1.30	0.888	-1.48	0.836	I(1)
		D	-5.84	0.000	-7.81	0.000	I(0)
ln (real price index of pipe and hand-rolling tobacco)	$\ln(P_{pt})$	L	-3.40	0.051	-3.31	0.065	I(1)
		D	-5.57	0.000	-6.95	0.000	I(0)
ln (real disposable income)	$\ln(Y_t)$	L	-2.20	0.490	-2.43	0.362	I(1)
		D	-5.16	0.000	-6.67	0.000	I(0)
tobacco control scale	TCS_t	L	-0.02	0.994	0.00	0.994	I(1)
		D	-5.86	0.000	-6.69	0.000	I(0)

Appendix D5. Testing the stationarity of the time series, Ireland 1970–2009

Description	Specification	Testing stationarity	ADF test		Phillips-Perron test		Level of integration
			Statistic	p	Statistic	p	
ln (number of cigarettes)	$\ln(Q_{st})$	L	-1.72	0.742	-1.43	0.853	I(1)
		D	-4.25	0.004	-5.01	0.000	I(0)
ln (real price index of cigarettes)	$\ln(P_{st})$	L	-3.26	0.073	-3.90	0.012	I(1)/I(0)
		D	-3.08	0.111	-3.53	0.036	I(1)/I(0)
ln (real disposable income)	$\ln(Y_t)$	L	-1.53	0.820	-1.26	0.897	I(1)
		D	-2.97	0.141	-4.20	0.005	I(1)/I(0)
tobacco control scale	TCS_t	L	-1.33	0.881	-0.94	0.952	I(1)
		D	-4.31	0.003	-5.06	0.000	I(0)

Appendix D6. Testing the stationarity of the time series, Italy 1970–2009

Description	Specification	Testing stationarity	ADF test		Phillips-Perron test		Level of integration
			Statistic	p	Statistic	p	
ln (number of cigarettes)	$\ln(Q_{st})$	L	-2.89	0.168	-2.37	0.396	I(1)
		D	-3.03	0.125	-3.94	0.011	I(0)/I(1)
ln (real price index of cigarettes)	$\ln(P_{st})$	L	-3.61	0.029	-3.19	0.086	I(1)/I(0)
		D	-4.13	0.006	-3.88	0.013	I(0)
ln (real disposable income)	$\ln(Y_t)$	L	-0.34	0.989	-0.19	0.992	I(1)
		D	-3.84	0.015	-4.79	0.001	I(0)
tobacco control scale	TCS_t	L	-2.82	0.191	-2.97	0.142	I(1)
		D	-4.48	0.002	-6.57	0.000	I(0)

Appendix D7. Testing the stationarity of the time series, Netherlands 1980–2009

Description	Specification	Testing stationarity	ADF test		Phillips-Perron test		Level of integration
			Statistic	p	Statistic	p	
ln (number of cigarettes)	$\ln(Q_{st})$	L	-3.02	0.126	-3.24	0.077	I(1)
		D	-5.08	0.000	-5.56	0.000	I(0)
ln (quantity of pipe and hand-rolling tobacco)	$\ln(Q_{pt})$	L	-3.59	0.030	-3.82	0.016	I(1)
		D	-3.97	0.010	-5.93	0.000	I(0)
ln (real price index of cigarettes)	$\ln(P_{st})$	L	-1.95	0.629	-1.76	0.725	I(1)
		D	-4.83	0.000	-4.13	0.006	I(0)
ln (real price index of pipe and hand-rolling tobacco)	$\ln(P_{pt})$	L	-3.34	0.060	-2.63	0.267	I(1)
		D	-4.48	0.002	-4.77	0.001	I(0)
ln (real disposable income)	$\ln(Y_t)$	L	-2.21	0.483	-2.38	0.388	I(1)
		D	-3.13	0.100	-3.98	0.010	I(0)
tobacco control scale	TCS_t	L	-1.97	0.620	-2.08	0.556	I(1)
		D	-3.65	0.026	-5.99	0.000	I(0)

Appendix D8. Testing the stationarity of the time series, Portugal 1970–2009

Description	Specification	Testing stationarity	ADF test		Phillips-Perron test		Level of integration
			Statistic	p	Statistic	p	
ln (quantity of cigarettes)	$\ln(Q_{st})$	L	-1.35	0.876	-0.13	0.993	I(1)
		D	-4.88	0.000	-4.62	0.001	I(0)
ln (real price index of cigarettes)	$\ln(P_{st})$	L	-3.90	0.012	-3.04	0.121	I(0)/I(1)
		D	-5.59	0.000	-6.57	0.000	I(0)
ln (real disposable income)	$\ln(Y_t)$	L	-2.70	0.235	-1.78	0.713	I(1)
		D	-4.21	0.004	-3.63	0.027	I(0)
tobacco control scale	TCS_t	L	-2.00	0.600	-2.21	0.483	I(1)
		D	-4.38	0.002	-6.73	0.000	I(0)

Appendix D9. Testing the stationarity of the time series, Spain 1960–2009

Description	Specification	Testing stationarity	ADF test		Phillips-Perron test		Level of integration
			Statistic	p	Statistic	p	
ln (quantity of cigarettes)	$\ln(Q_{st})$	L	-1.37	0.869	-1.36	0.872	I(1)
		D	-6.52	0.000	-7.74	0.000	I(0)
ln (real price index of cigarettes)	$\ln(P_{st})$	L	-0.73	0.971	-0.68	0.974	I(1)
		D	-5.06	0.000	-7.07	0.000	I(0)
ln (real disposable income)	$\ln(Y_t)$	L	-2.09	0.554	-3.20	0.084	I(1)
		D	-2.99	0.135	-3.57	0.032	I(1)/I(0)
tobacco control scale	TCS_t	L	-0.68	0.974	-0.81	0.965	I(1)
		D	-5.44	0.000	-7.47	0.000	I(0)

Appendix D10. Testing the stationarity of the time series, Sweden 1955–2009

Description	Specification	Testing stationarity	ADF test		Phillips-Perron test		Level of integration
			Statistic	p	Statistic	p	
ln (number of cigarettes)	$\ln(Q_{st})$	L	-1.38	0.867	-1.17	0.916	I(1)
		D	-6.03	0.000	-9.03	0.000	I(0)
ln (quantity of snus)	$\ln(Q_{snust})$	L	-2.36	0.399	-2.25	0.462	I(1)
		D	-4.40	0.002	-5.46	0.000	I(0)
ln (real price index of cigarettes)	$\ln(P_{st})$	L	-1.22	0.906	-1.48	0.837	I(1)
		D	-6.25	0.000	-8.13	0.000	I(0)
ln (real price index of snus)	$\ln(P_{snust})$	L	-0.45	0.985	-0.54	0.982	I(1)
		D	-5.69	0.000	-7.00	0.000	I(0)
ln (real disposable income)	$\ln(Y_t)$	L	-2.71	0.234	-1.79	0.709	I(1)
		D	-4.55	0.001	-4.05	0.008	I(0)
tobacco control scale	TCS_t	L	-1.50	0.829	-1.58	0.801	I(1)
		D	-5.67	0.000	-7.96	0.000	I(0)

Appendix D11. Testing the stationarity of the time series, United Kingdom 1953–2009

Description	Specification	Testing stationarity	ADF test		Phillips-Perron test		Level of integration
			Statistic	p	Statistic	p	
ln (number of cigarettes)	$\ln(Q_{st})$	L	-1.68	0.759	-1.58	0.802	I(1)
		D	-4.55	0.001	-5.04	0.000	I(0)
ln (real price index of cigarettes)	$\ln(P_{st})$	L	-1.43	0.851	-1.21	0.908	I(1)
		D	-4.33	0.003	-4.40	0.002	I(0)
ln (real disposable income)	$\ln(Y_t)$	L	-3.31	0.064	-2.74	0.220	I(1)
		D	-6.30	0.000	-6.13	0.000	I(0)
tobacco control scale	TCS_t	L	0.79	1.000	1.74	1.000	I(1)
		D	-4.24	0.004	-5.33	0.000	I(0)

Appendices E1–E11.

Time-series graphs of the variables used

Appendix E1. Austria 1976–2009, cigarette consumption

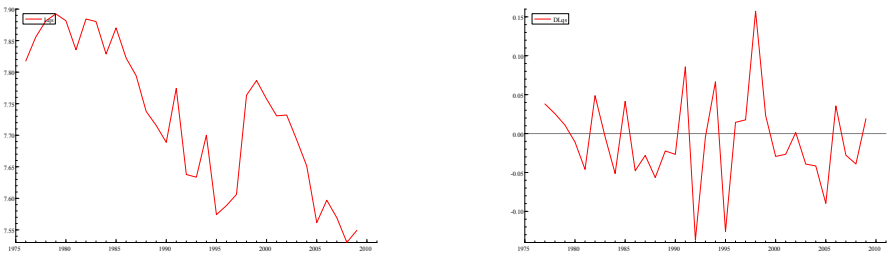


Figure E1a. Consumption in log-level form (left) and in log-first-difference form (right)

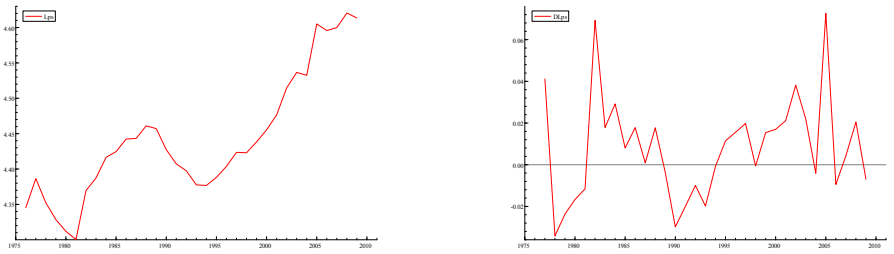


Figure E1b. Real price index in log-level form (left) and in log-first-difference form (right)

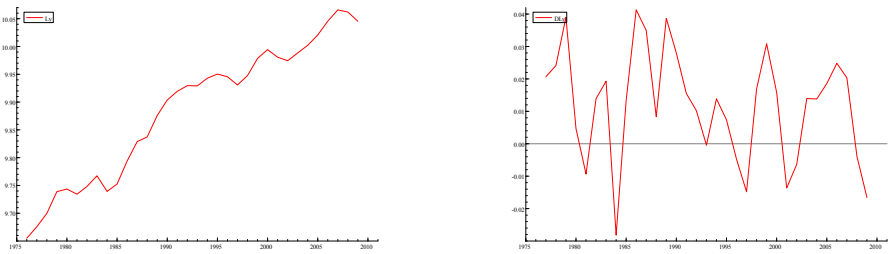


Figure E1c. Real income in log-level form (left) and in log-first-difference form (right)

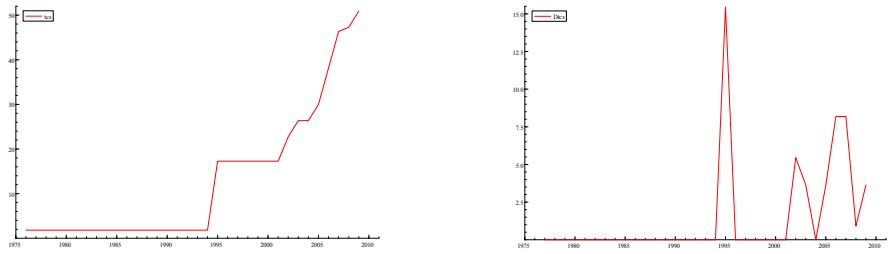


Figure E1d. Tobacco control policy index in log-level form (left) and in log-first-difference form (right)

Appendix E2. Finland 1960–2009, consumption of cigarettes and pipe and hand-rolling tobacco

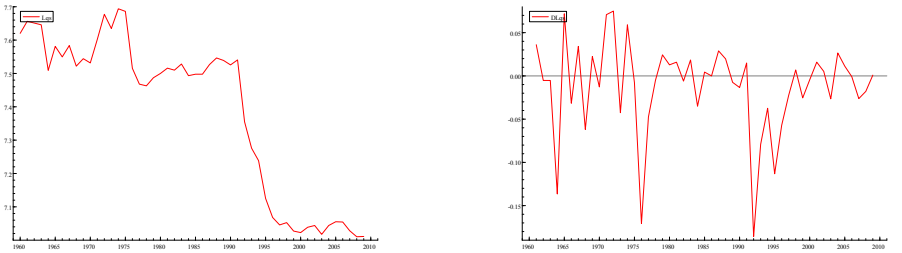


Figure E2a. Cigarette consumption in log-level form (left) and in log-first-difference form (right)

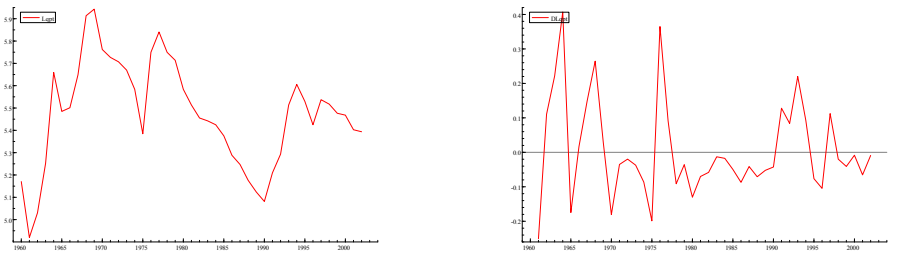


Figure E2b. Consumption of pipe and hand-rolling tobacco in log-level form (left) and in log-first-difference form (right)

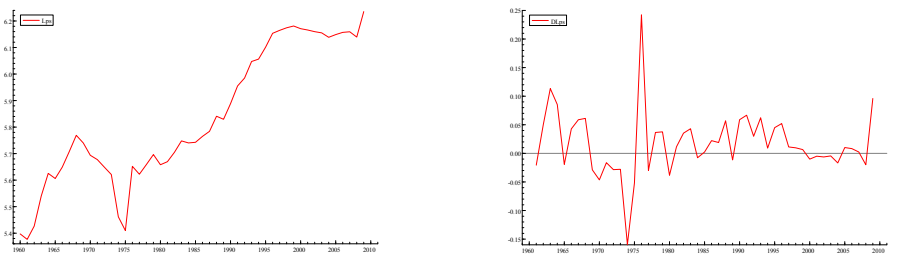


Figure E2c. Real cigarette price index in log-level form (left) and in log-first-difference form (right)

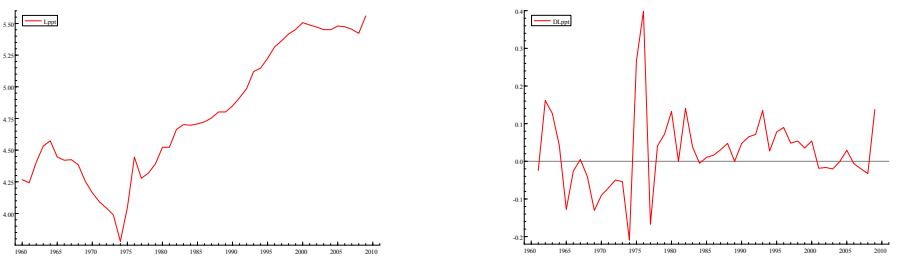


Figure E2d. Real price index of pipe and hand-rolling tobacco in log-level form (left) and in log-first-difference form (right)

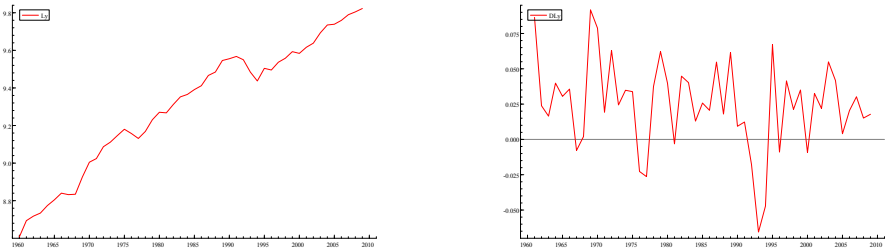


Figure E2e. Real income in log-level form (left) and in log-first-difference form (right)

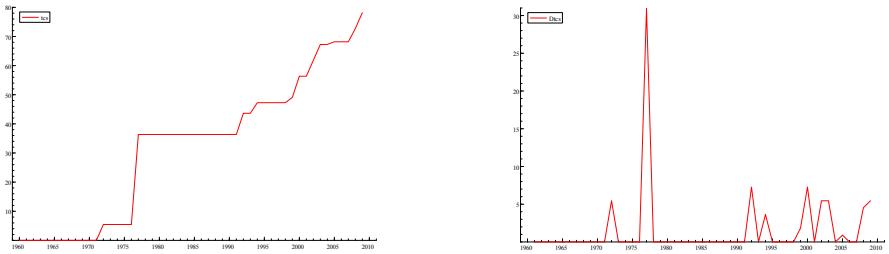


Figure E2f. Tobacco control policy index in log-level form (left) and in log-first-difference form (right)

Appendix E3. France 1950–2009, cigarette consumption

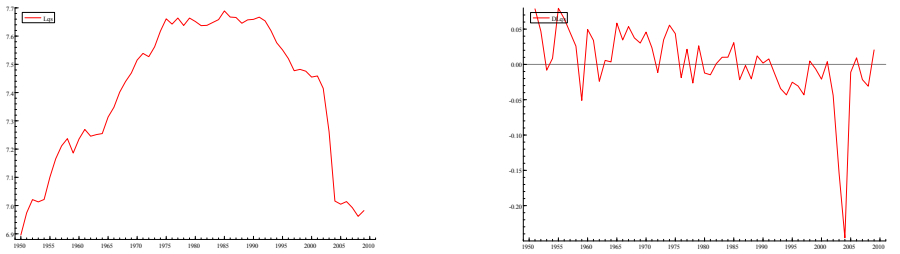


Figure E3a. Consumption in log-level form (left) and in log-first-difference form (right)

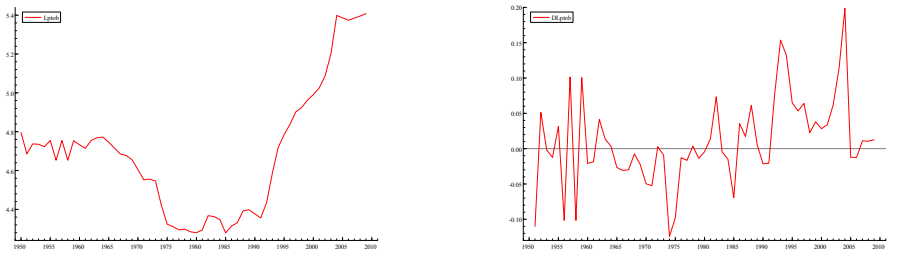


Figure E3b. Real price index in log-level form (left) and in log-first-difference form (right)

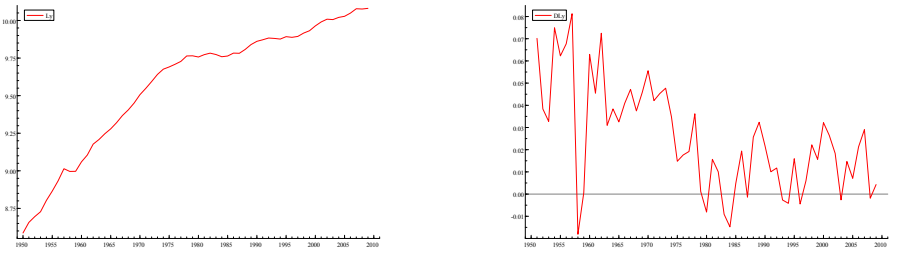


Figure E3c. Real income in log-level form (left) and in log-first-difference form (right)

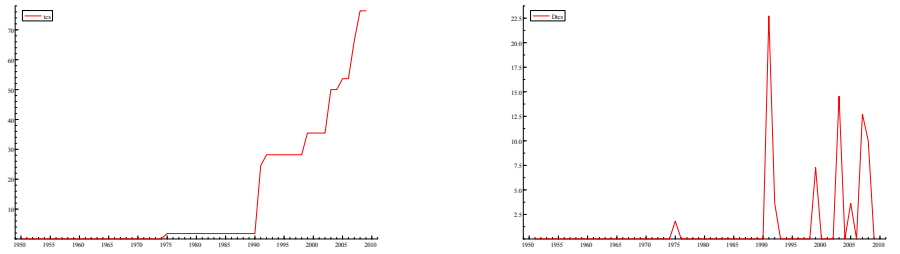


Figure E3d. Tobacco control policy index in log-level form (left) and in log-first-difference form (right)

Appendix E4. Germany 1960–2009, cigarette consumption

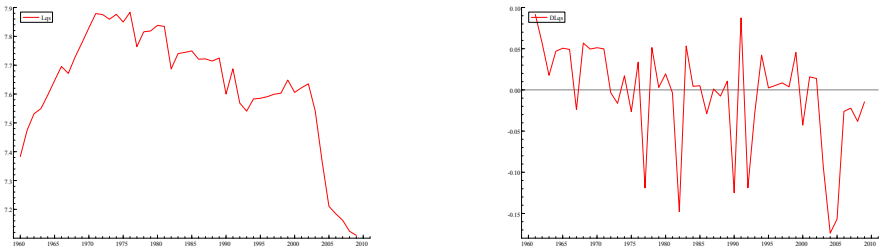


Figure E4a. Consumption in log-level form (left) and in log-first-difference form (right)

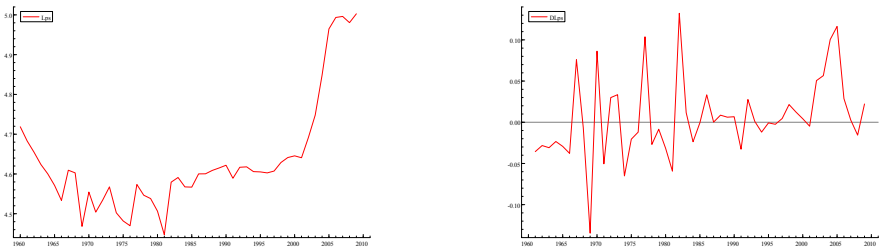


Figure E4b. Real price index in log-level form (left) and in log-first-difference form (right)

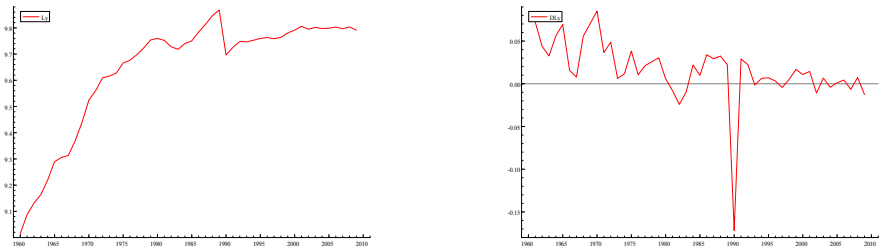


Figure E4c. Real income in log-level form (left) and in log-first-difference form (right)

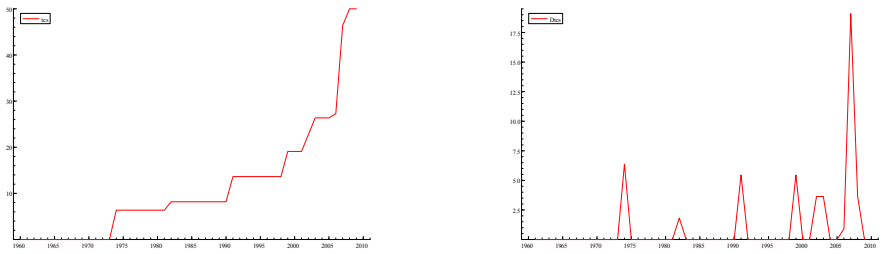


Figure E4d. Tobacco control policy index in log-level form (left) and in log-first-difference form (right)

Appendix E5. Ireland 1970–2009, cigarette consumption

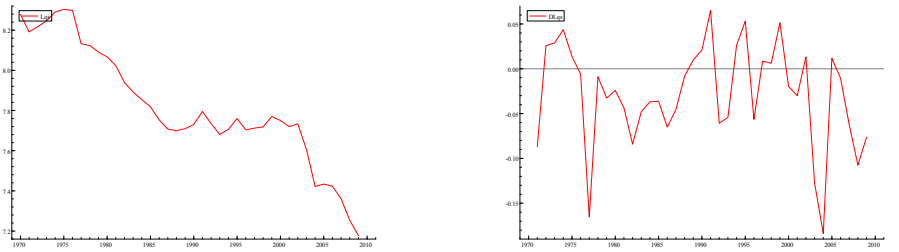


Figure E5a. Consumption in log-level form (left) and in log-first-difference form (right)

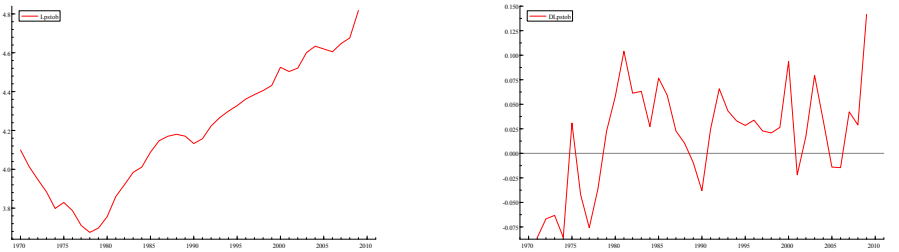


Figure E5b. Real price index in log-level form (left) and in log-first-difference form (right)

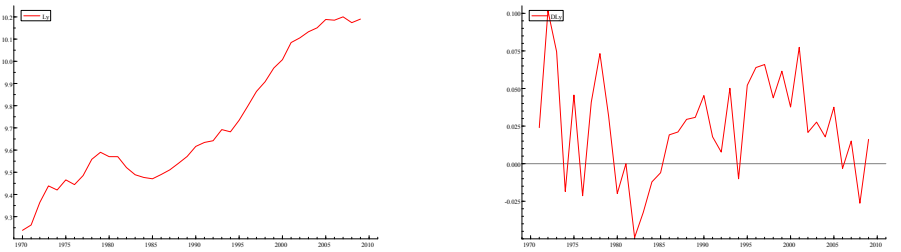


Figure E5c. Real income in log-level form (left) and in log-first-difference form (right)

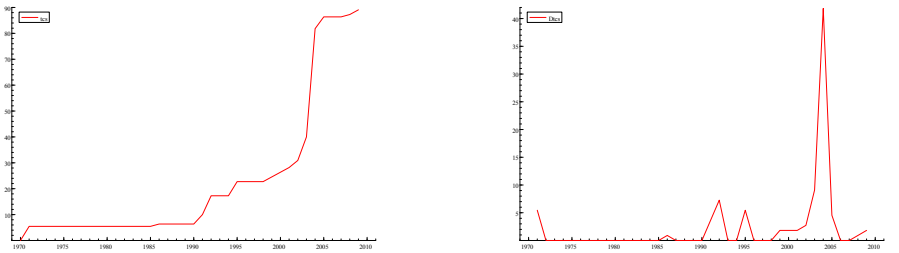


Figure E5d. Tobacco control policy index in log-level form (left) and in log-first-difference form (right)

Appendix E6. Italy 1970–2009, cigarette consumption

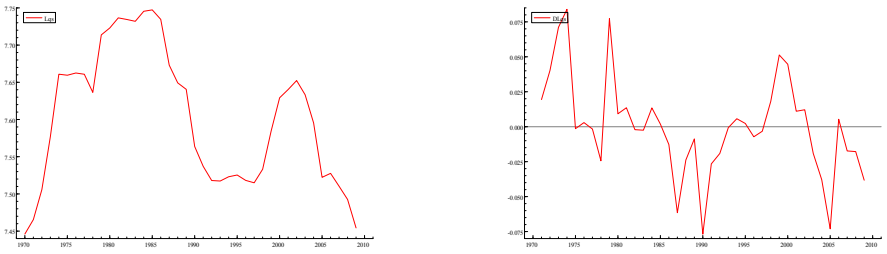


Figure E6a. Consumption in log-level form (left) and in log-first-difference form (right)

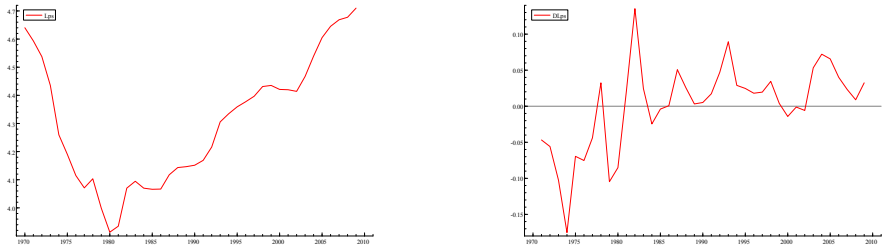


Figure E6b. Real price index in log-level form (left) and in log-first-difference form (right)

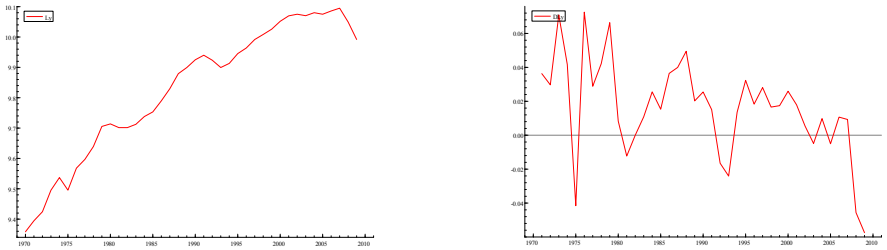


Figure E6c. Real income in log-level form (left) and in log-first-difference form (right)

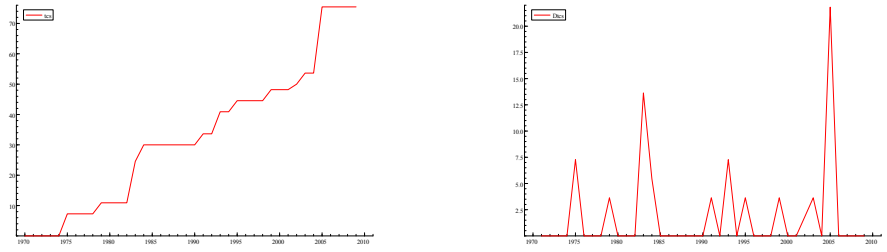


Figure E6d. Tobacco control policy index in log-level form (left) and in log-first-difference form (right)

Appendix E7. Netherlands 1980–2009, consumption of cigarettes and pipe and hand-rolling tobacco

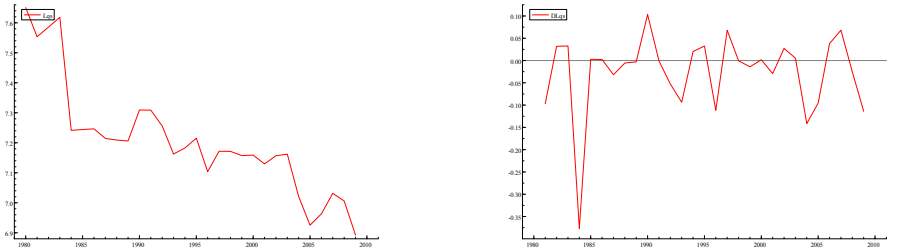


Figure E7a. Cigarette consumption in log-level form (left) and in log-first-difference form (right)

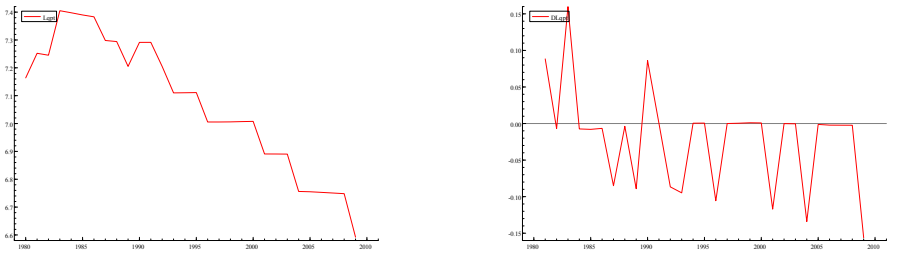


Figure E7b. Consumption of pipe and hand-rolling tobacco in log-level form (left) and in log-first-difference form (right)

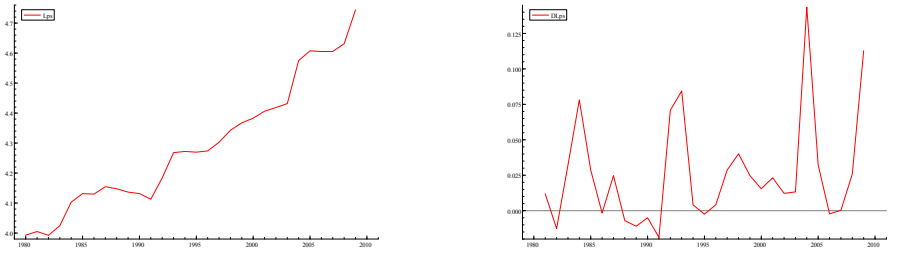


Figure E7c. Real cigarette price index in log-level form (left) and in log-first-difference form (right)

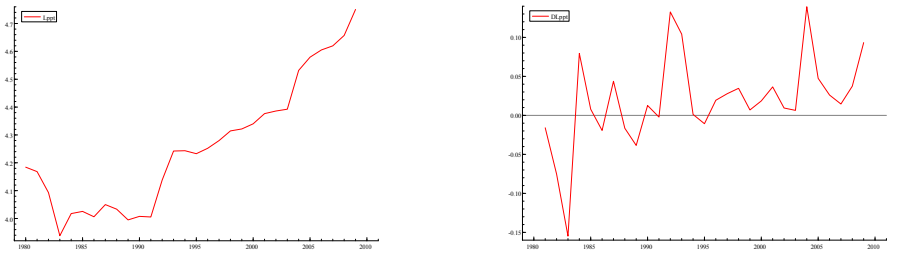


Figure E7d. Real price index of pipe and hand-rolling tobacco in log-level form (left) and in log-first-difference form (right)

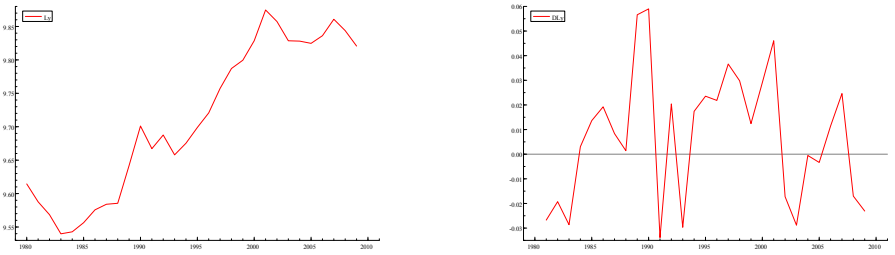


Figure E7e. Real income in log-level form (left) and in log-first-difference form (right)

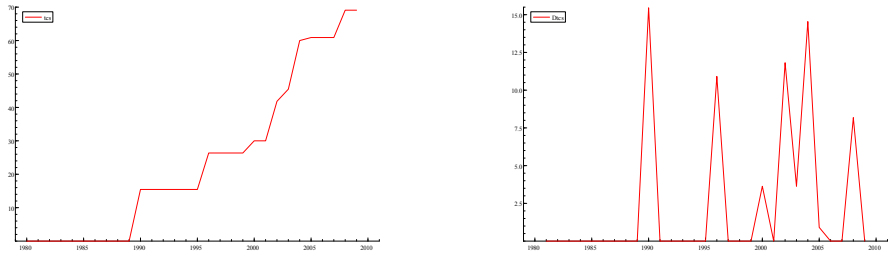


Figure E7f. Tobacco control policy index in log-level form (left) and in log-first-difference form (right)

Appendix E8. Portugal 1970–2009, cigarette consumption

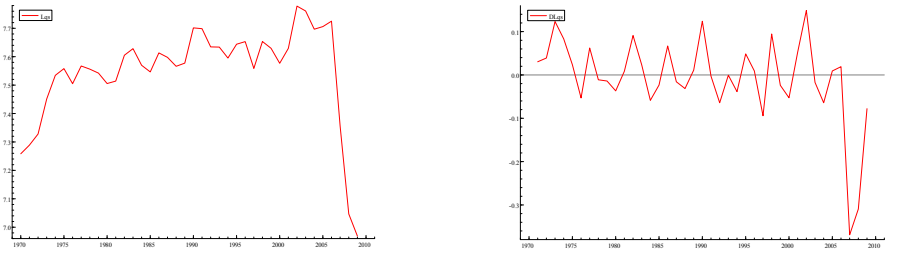


Figure E8a. Consumption in log-level form (left) and in log-first-difference form (right)

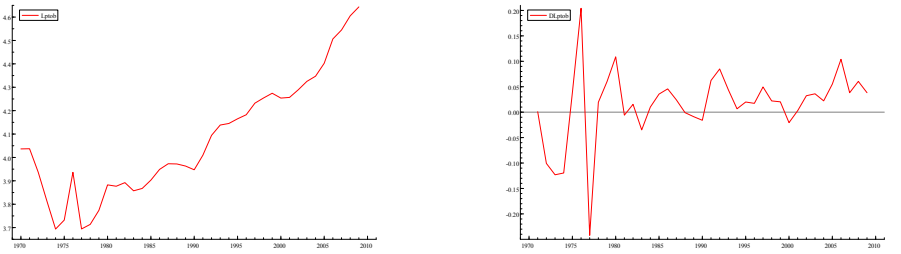


Figure E8b. Real price index in log-level form (left) and in log-first-difference form (right)

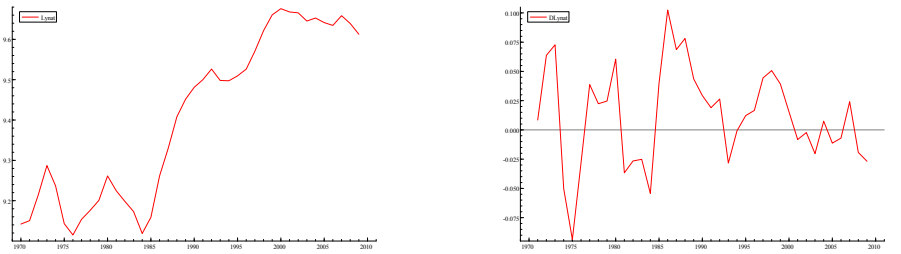


Figure E8c. Real income in log-level form (left) and in log-first-difference form (right)

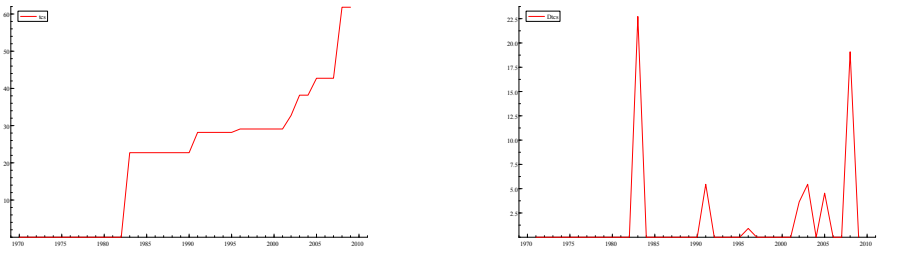


Figure E8d. Tobacco control policy index in log-level form (left) and in log-first-difference form (right)

Appendix E9. Spain 1960–2009, cigarette consumption

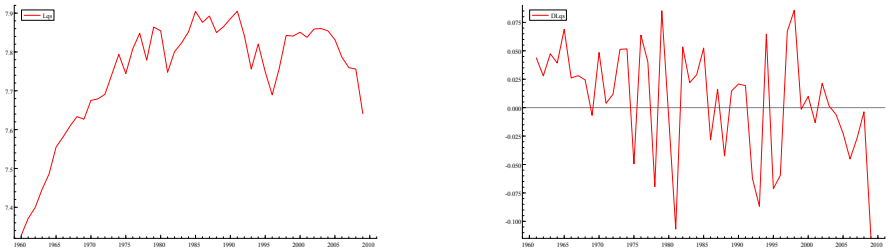


Figure E9a. Consumption in log-level form (left) and in log-first-difference form (right)

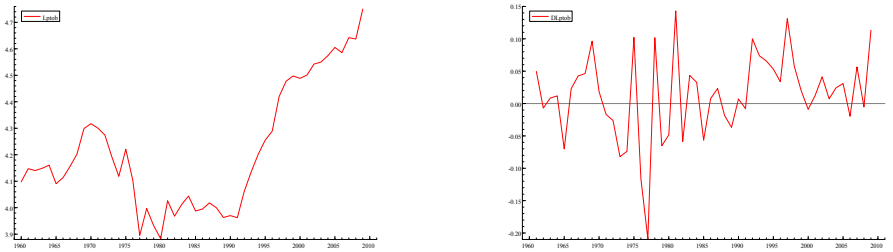


Figure E9b. Real price index in log-level form (left) and in log-first-difference form (right)

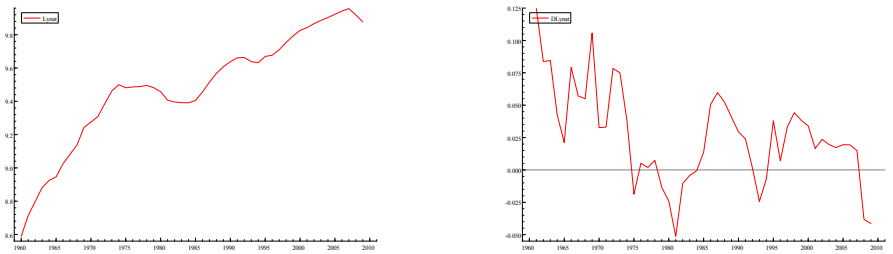


Figure E9c. Real income in log-level form (left) and in log-first-difference form (right)

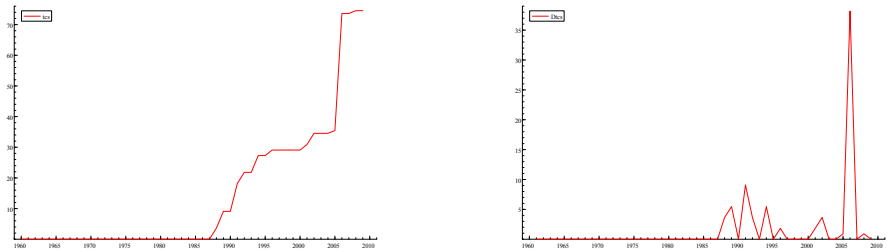


Figure E9d. Tobacco control policy index in log-level form (left) and in log-first-difference form (right)

Appendix E10. Sweden 1955–2009, consumption of cigarettes and snus

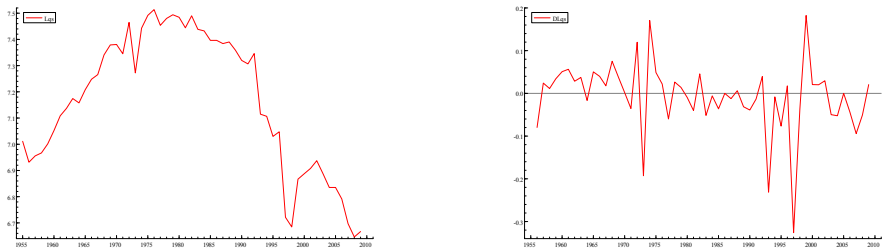


Figure E10a. Cigarette consumption in log-level form (left) and in log-first-difference form (right)

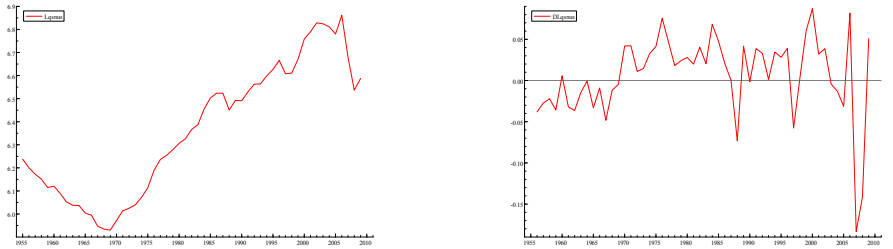


Figure E10b. Consumption of snus in log-level form (left) and in log-first-difference form (right)

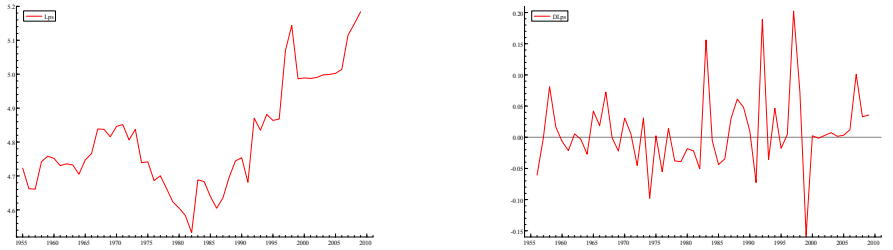


Figure E10c. Real cigarette price index in log-level form (left) and in log-first-difference form (right)

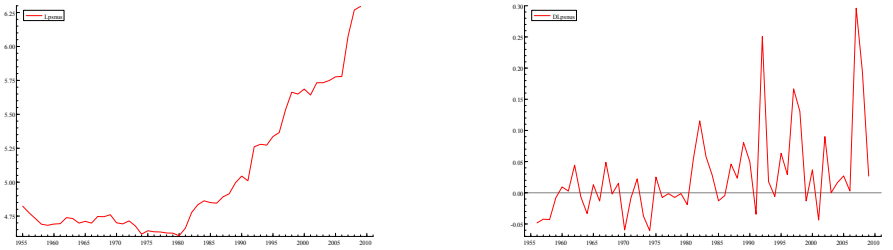


Figure E10d. Real price index of snus in log-level form (left) and in log-first-difference form (right)

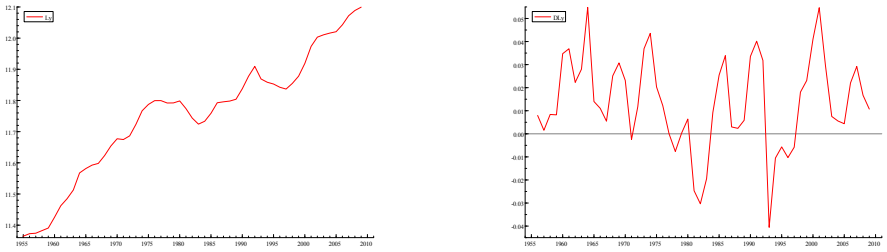


Figure E10e. Real income in log-level form (left) and in log-first-difference form (right)

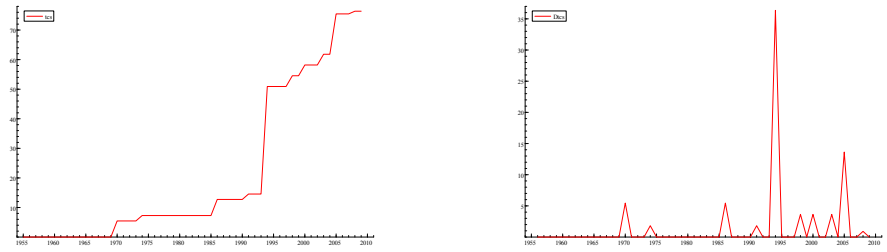


Figure E10f. Tobacco control policy index in log-level form (left) and in log-first-difference form (right)

Appendix E11. United Kingdom 1953–2009, cigarette consumption

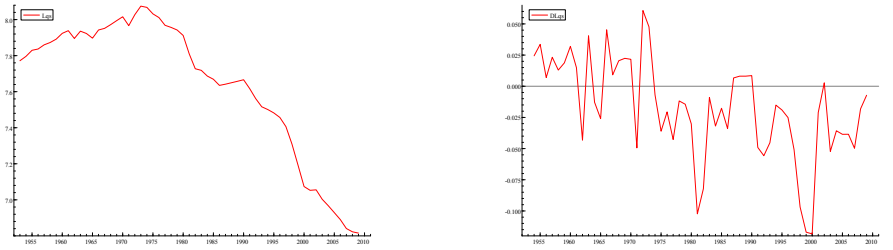


Figure 11a. Consumption in log-level form (left) and in log-first-difference form (right)

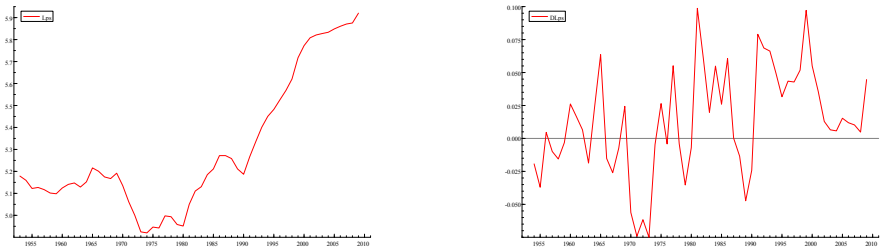


Figure 11b. Real price index in log-level form (left) and in log-first-difference form (right)

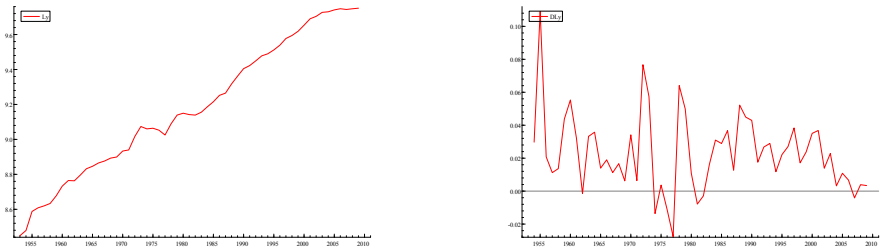


Figure 11c. Real income in log-level form (left) and in log-first-difference form (right)

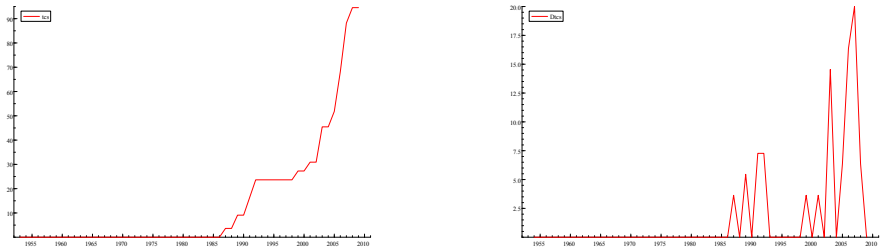


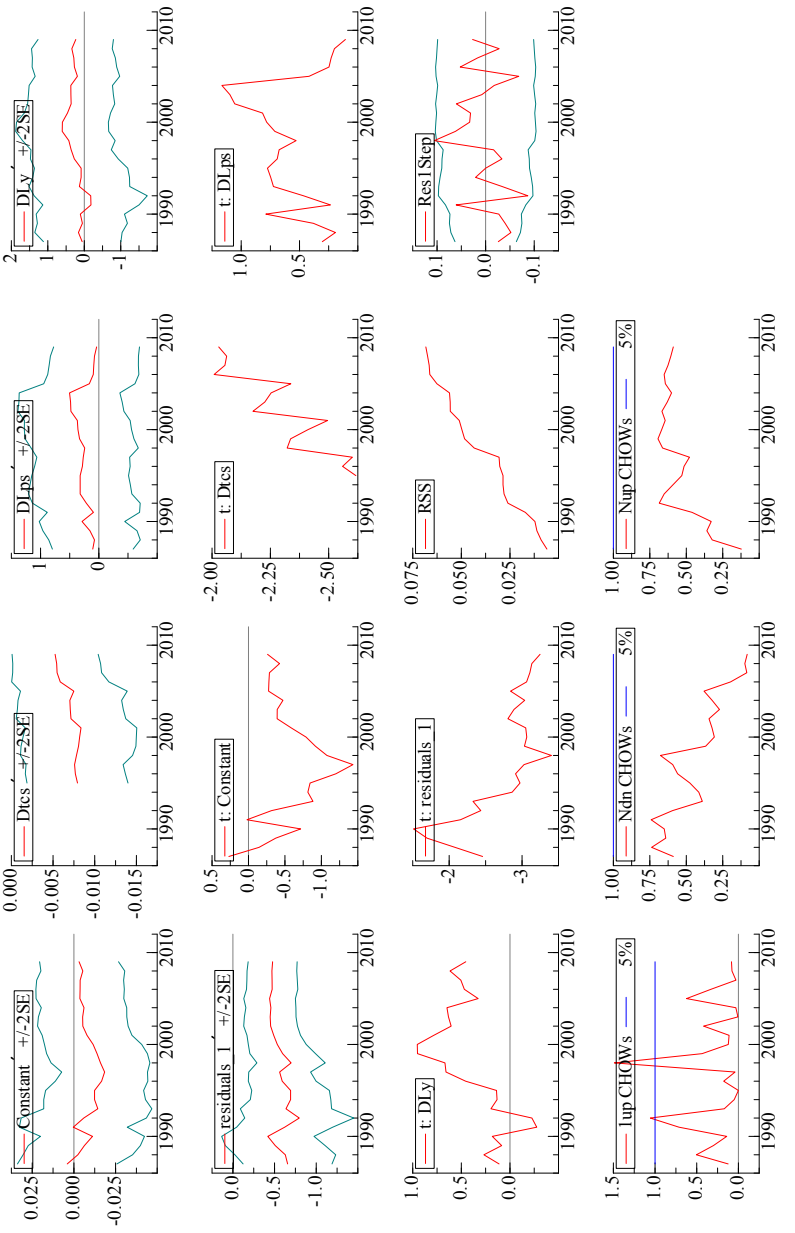
Figure 11d. Tobacco control policy index in log-level form (left) and in log-first-difference form (right)

Appendices F1–F14.

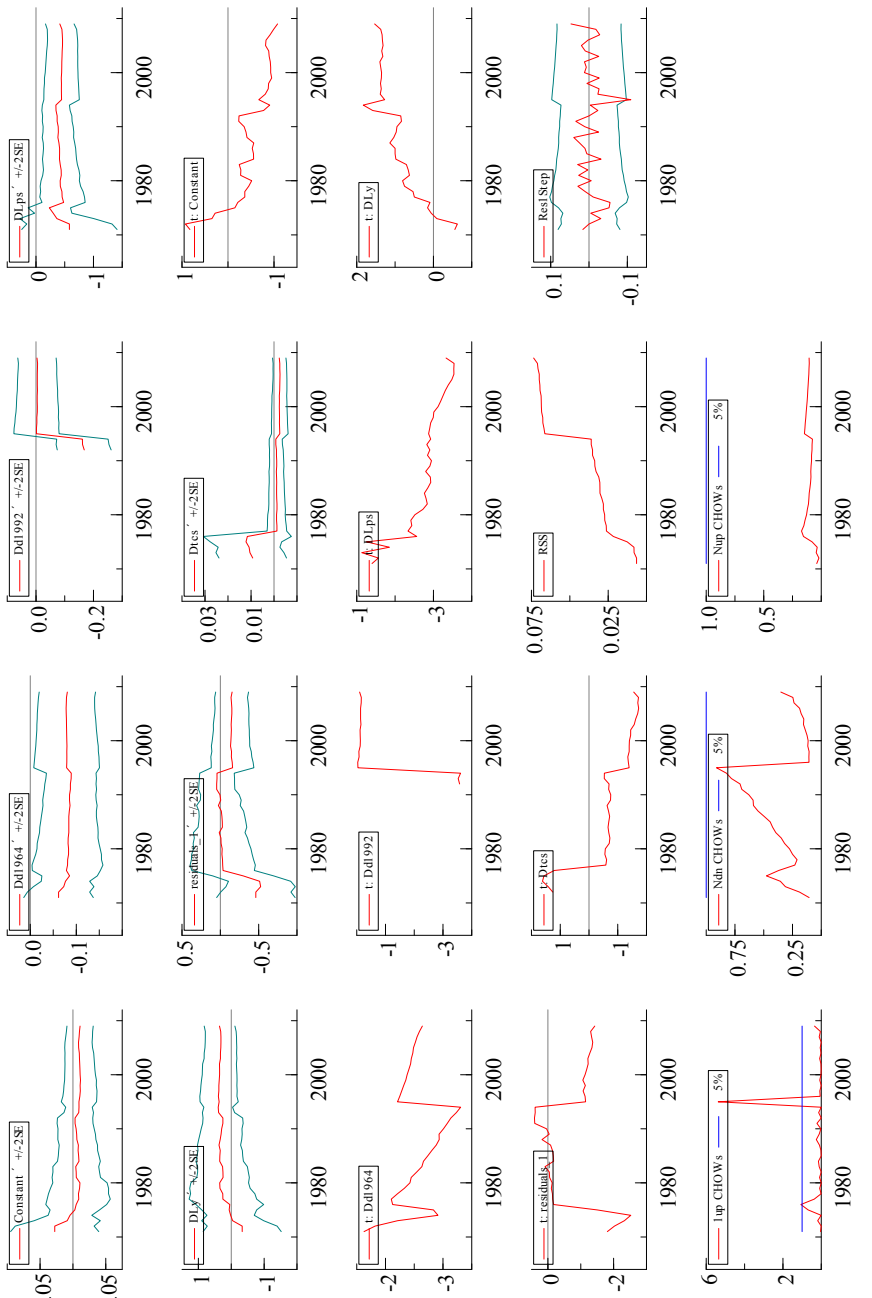
Recursive least squares graphical constancy statistics

In the following appendices, recursive least squares graphical constancy statistics are introduced for all the estimated error correction models that are earlier reported in the country-specific analyses 7.2–7.12.

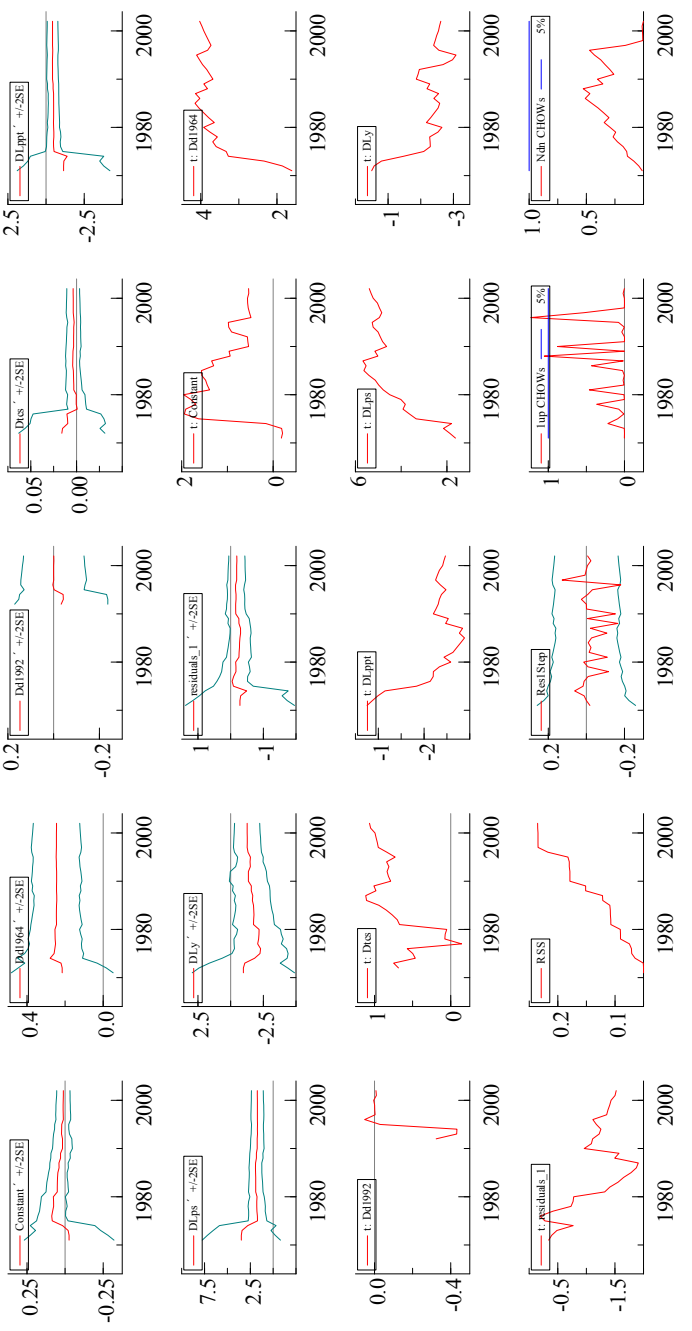
Appendix F1. Austria 1976–2009, cigarette consumption



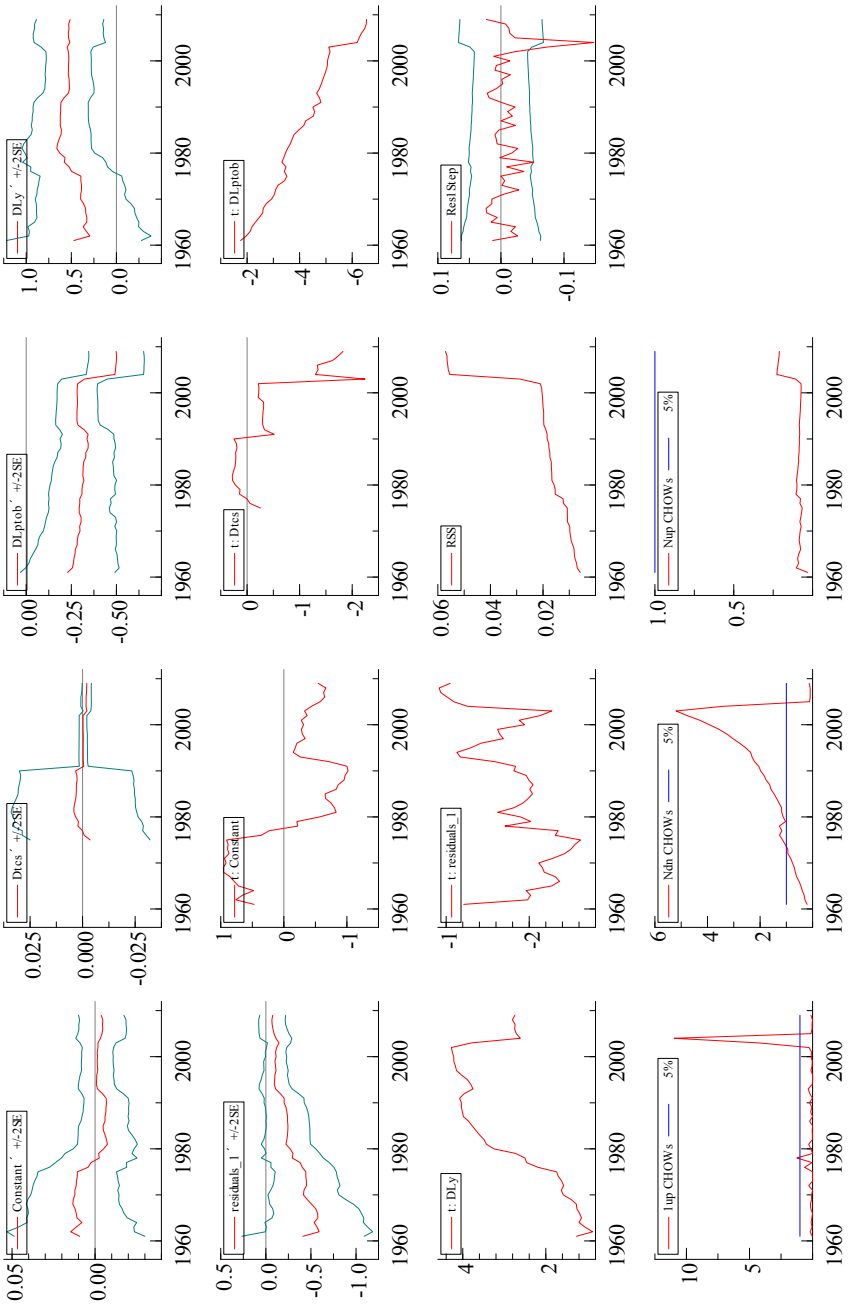
Appendix F2. Finland 1960–2009, cigarette consumption



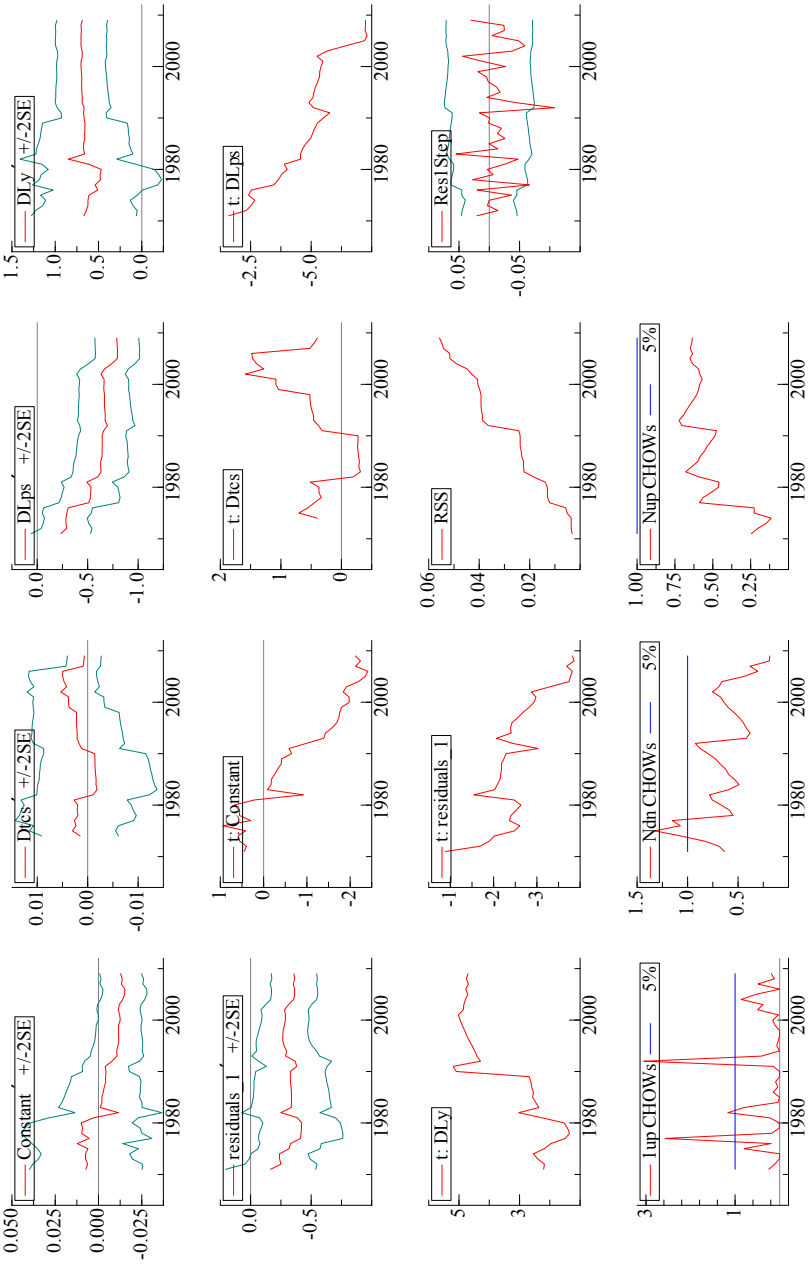
Appendix F3. Finland 1960–2002, consumption of pipe and hand-rolling tobacco



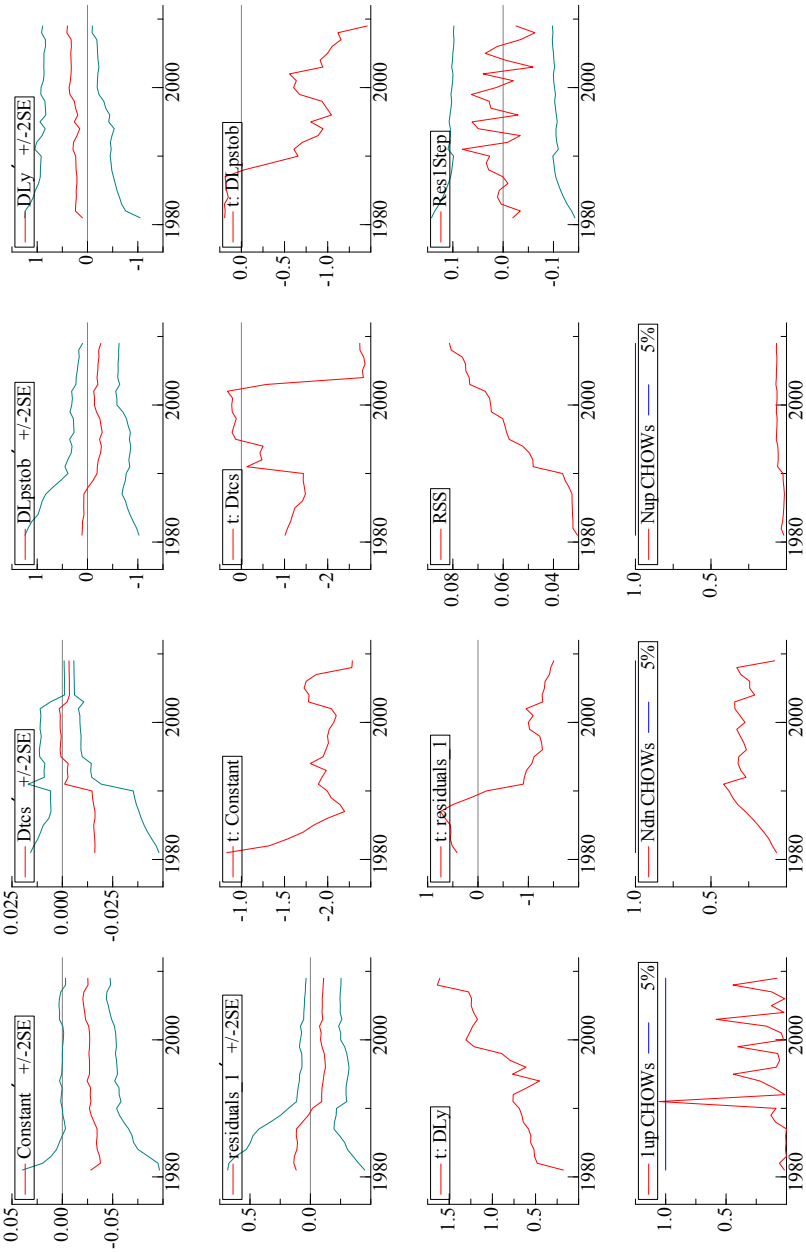
Appendix F4. France 1950–2009, cigarette consumption



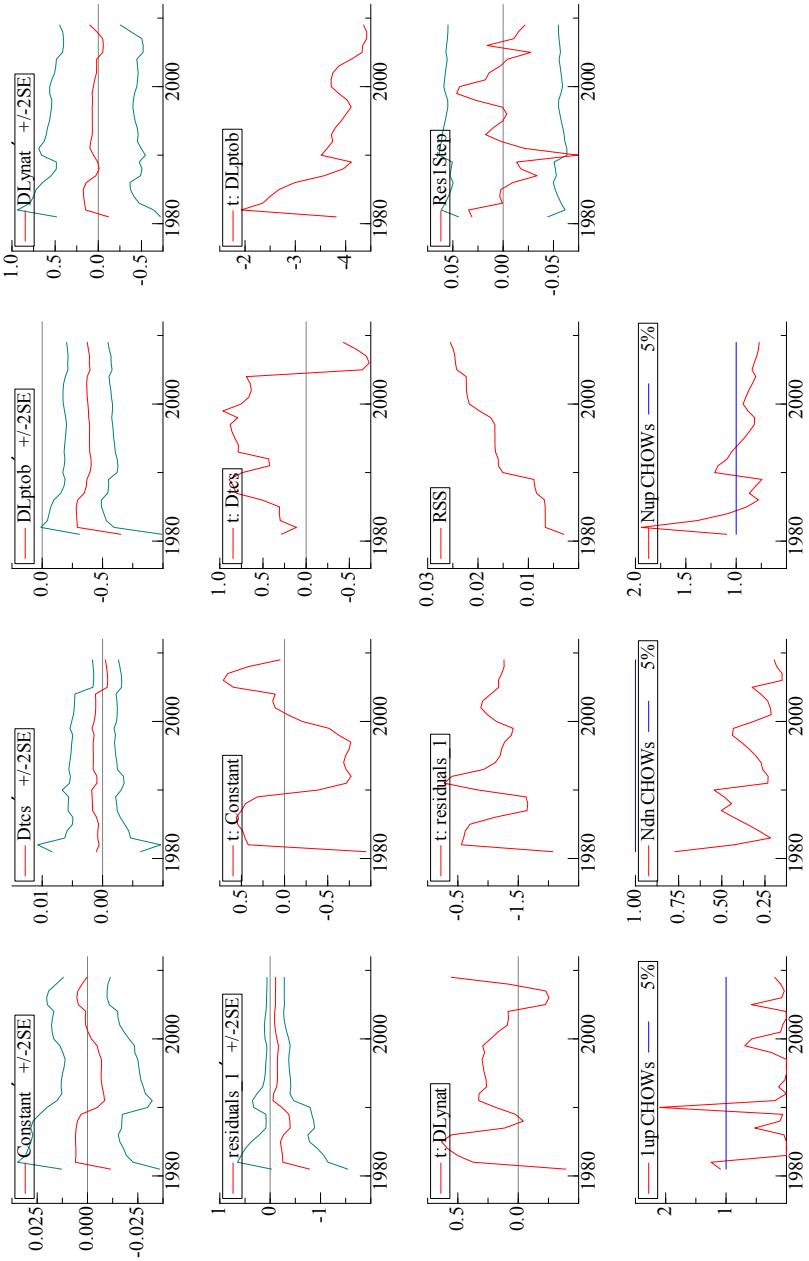
Appendix F5. Germany 1960–2009, cigarette consumption



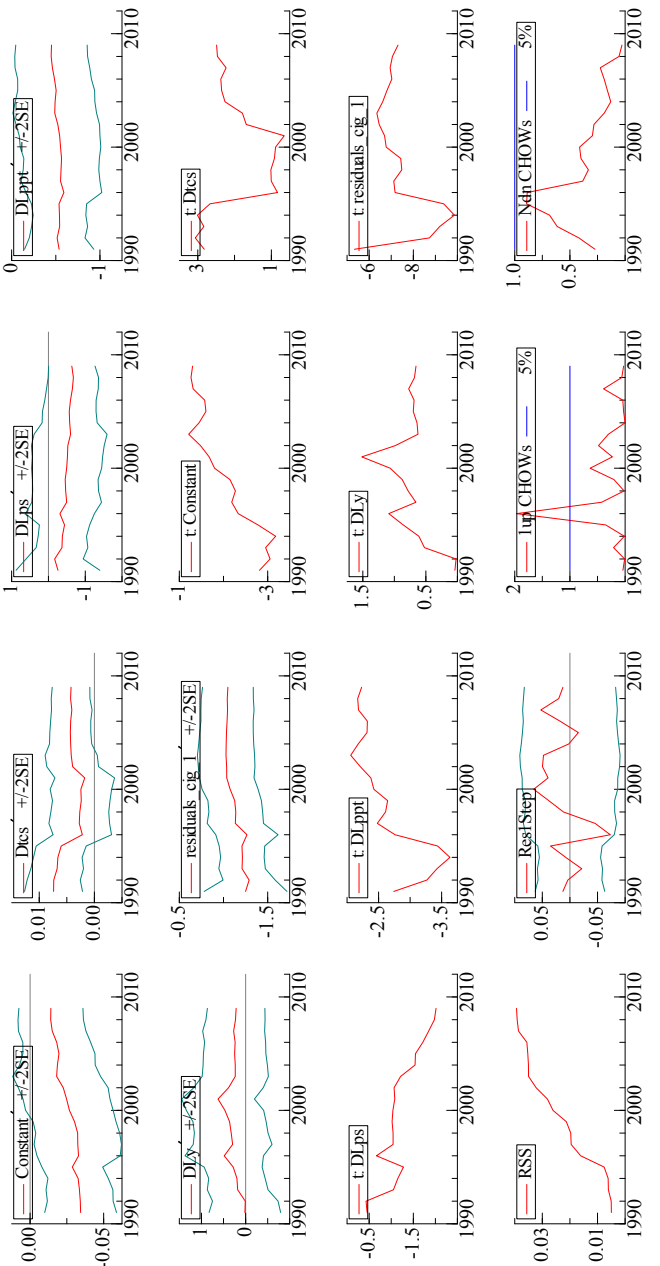
Appendix F6. Ireland 1970–2009, cigarette consumption



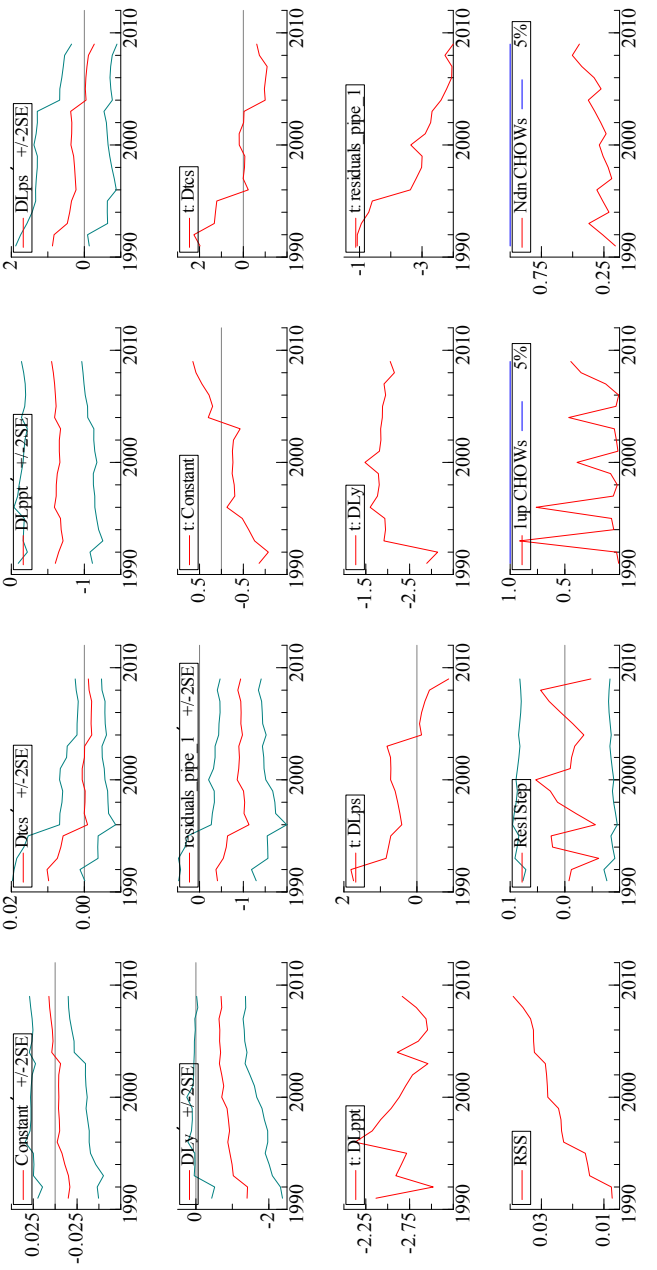
Appendix F7. Italy 1970–2009, cigarette consumption



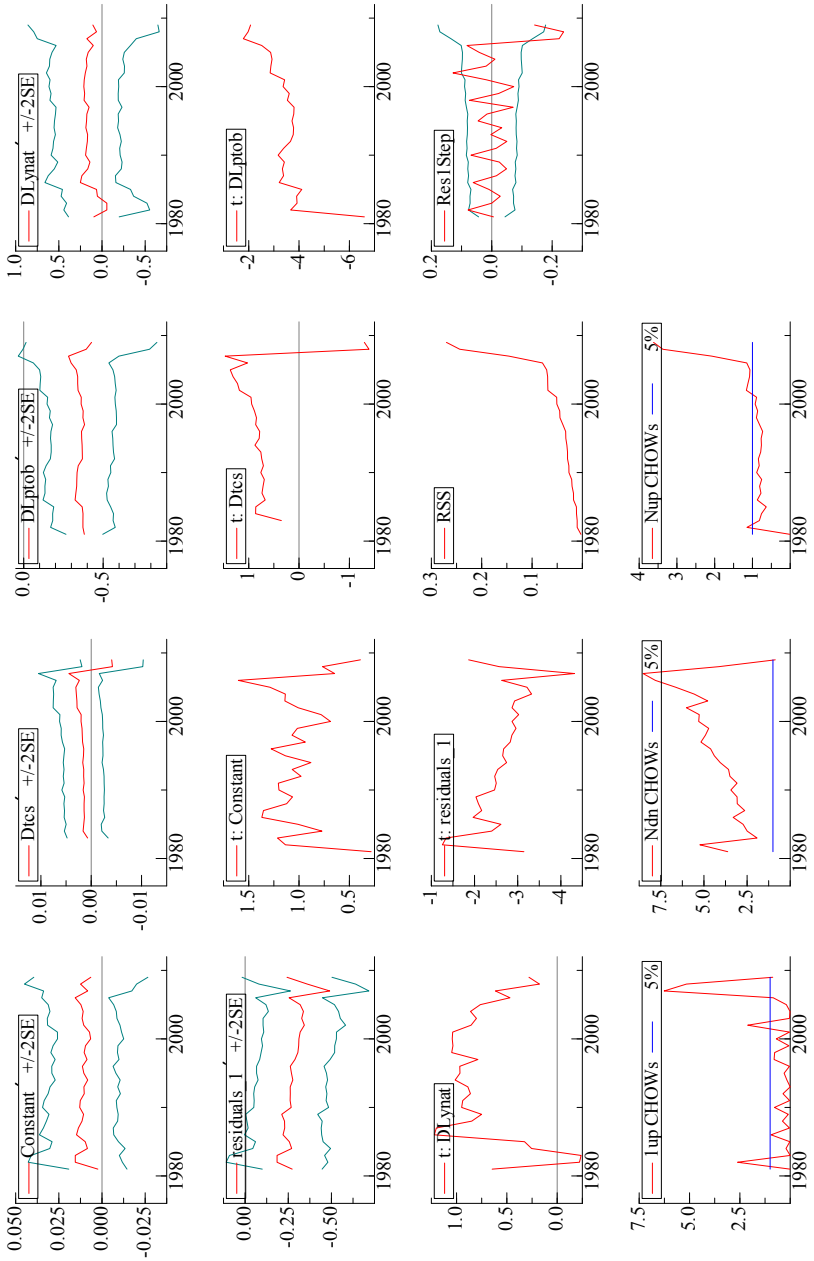
Appendix F8. Netherlands 1980–2009, cigarette consumption



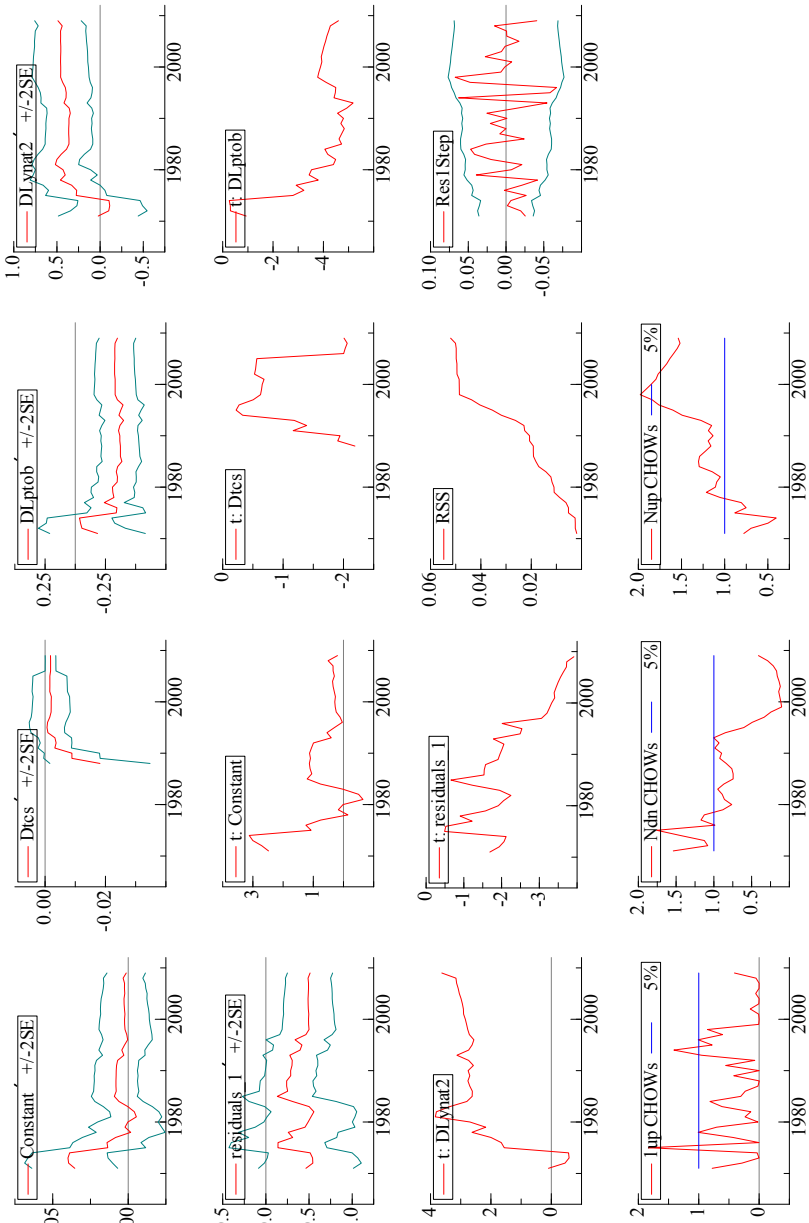
Appendix F9. Netherlands 1980–2009, consumption of pipe and hand-rolling tobacco



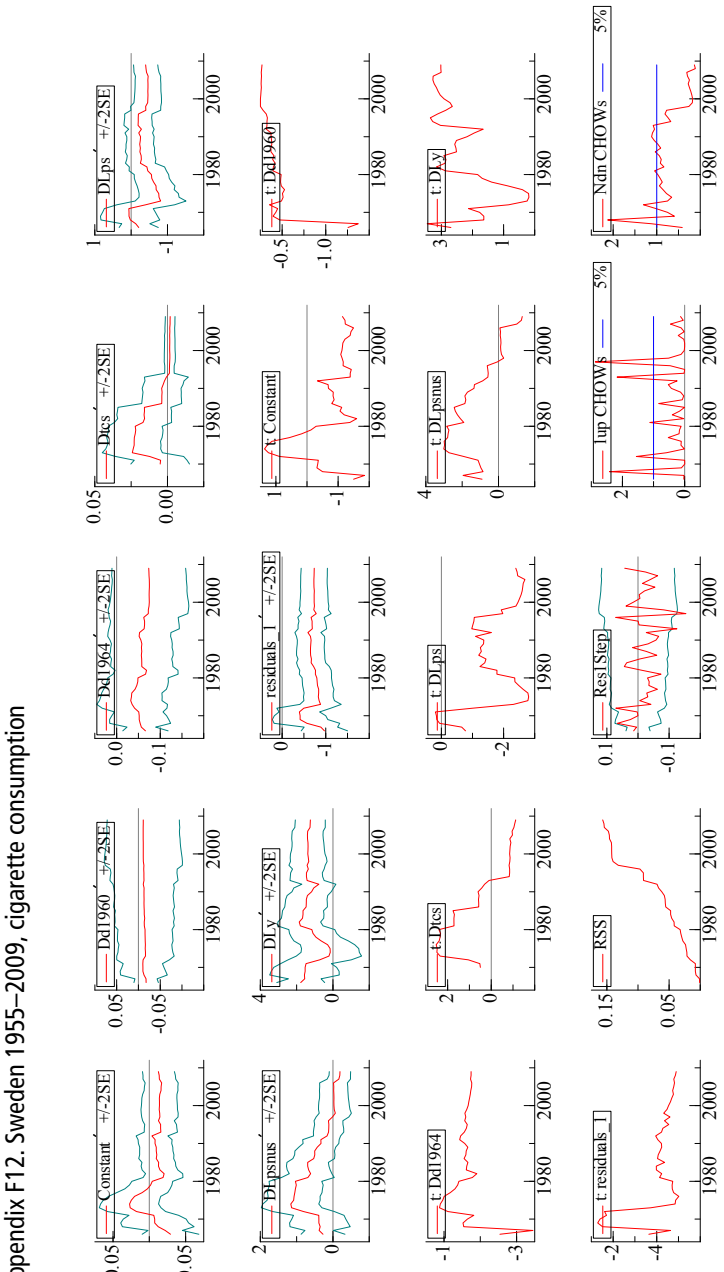
Appendix F10. Portugal 1970–2009, cigarette consumption



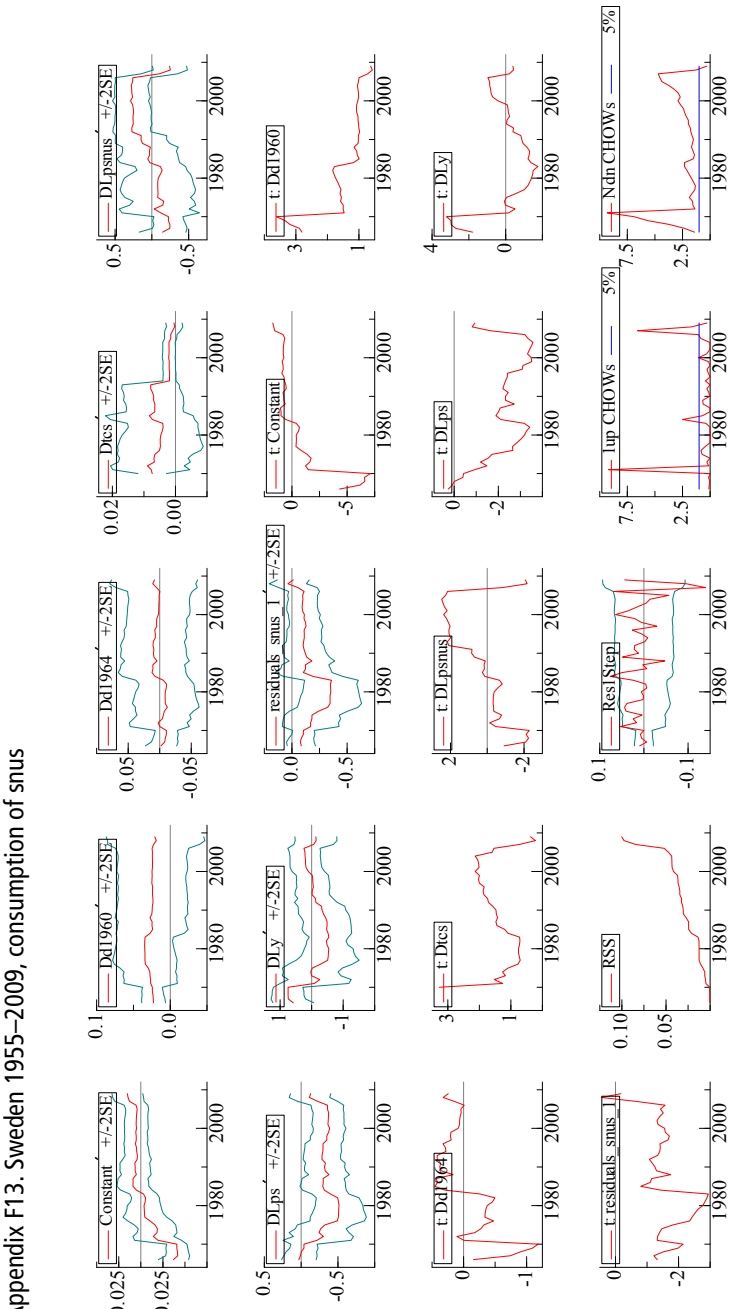
Appendix F11. Spain 1960–2009, cigarette consumption



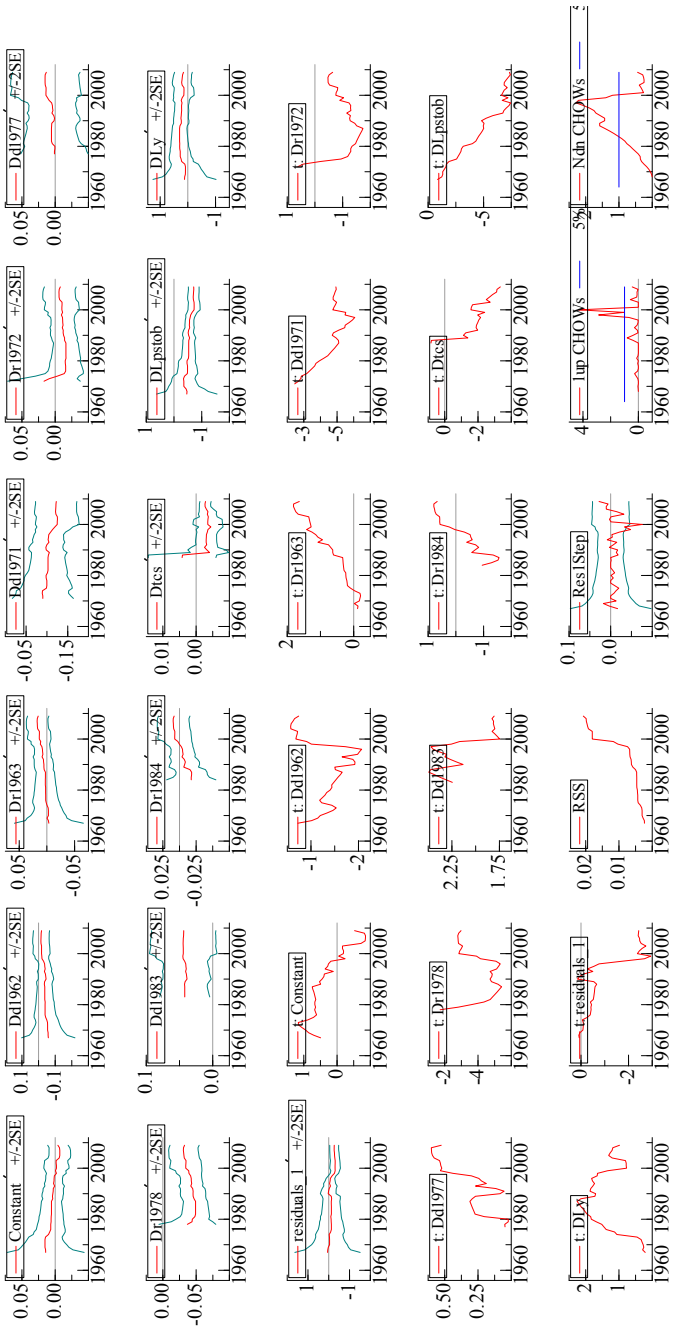
Appendix F12. Sweden 1955–2009, cigarette consumption



Appendix F13. Sweden 1955–2009, consumption of snus



Appendix F14. United Kingdom 1953–2009, cigarette consumption



REPORT

Lien Nguyen
Gunnar Rosenqvist
Markku Pekurinen

Demand for Tobacco in Europe

An Econometric Analysis of 11 Countries for the PPACTE Project

Tobacco smoking is regarded as the leading cause of preventable death globally. Tobacco tax increases and other control policies, such as restrictions and comprehensive bans on smoking and on smoking-related advertising as well as dissemination of information about health risks from smoking are generally regarded as effective in reducing tobacco use.

This study investigated the impacts of prices and other control policies on tobacco consumption in 11 EU countries comprising Austria, Finland, France, Germany, Ireland, Italy, the Netherlands, Portugal, Spain, Sweden, and the United Kingdom. Consistent econometric analyses were conducted for each country using exceptionally long annual time-series data covering 30–60 years.

The results imply that price increases and other control policies are clearly effective in reducing cigarette consumption. Tobacco policies should also more effectively highlight the harmful health effects of tobacco products other than cigarettes. Tobacco policies also need to take account of developments in real disposable income to improve their effectiveness.

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