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Cigarette Demand, Structural Change, and Advertising Bans: International Evidence, 1970-1995

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Abstract

Using panel data for a cross-section of countries, several previous studies estimate the effect of advertising bans on cigarette consumption. These studies suffer from three problems: (1) structural change in cigarette demand functions; (2) endogeneity of advertising bans; and (3) non-stationarity of cigarette consumption data. Using annual data for 20 OECD countries, this study tests for unit roots. Growth rates of cigarette consumption (log differences) are stationary, but levels data are not. I estimate single-equation panel models for 1970-1995 and test formally for structural change. The tests and recursive coefficient estimates confirm a regime change beginning in 1985. Results for different time periods are reported for the effects of price, income, health warnings, country fixed-effects, and moderate and strong advertising bans. The study also considers the possibility of endogenous advertising bans. A public-choice model is estimated as a two-equation model of advertising legislation and cigarette demand. The adoption of advertising bans is modeled as a Poisson count regression, and fitted values for the number of banned media are used as instruments in the demand equation. The results in the paper fail to demonstrate that advertising bans reduce aggregate cigarette consumption. Empirical results in previous studies are not robust to use of stationary data; refinements in model specification; different time periods; and endogeneity of advertising bans. Due to a decline in smoking prevalence, especially among males, there was a change in the political climate in favor of stronger restrictions on cigarette advertising. Overall, advertising bans have had no effect on cigarette consumption, regardless of the time period considered or the severity of the bans.

KEYWORDS: Tobacco Industry, Regulation, Advertising Bans

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1. Introduction

Do bans of cigarette advertising lead to reductions in smoking? Two opposing answers have been offered. First, the "industry position" is that advertising encourages brand switching and has little or no effect on market-wide consumption of cigarettes and other tobacco products. According this view, other factors such as the influence of peers, parents, and prices affect the initiation, continuance, and quantity of smoking. Hence, advertising bans have little or no effect on consumption and create mobility barriers for non-dominant brands, including brands offering reduced levels of "tar" and nicotine.[1] Similar arguments have been applied by economists to a broad array of mature products where brand differentiation is important (Calfee 1997; Oliver 1987; Scherer and Ross 1990). Advertising also increases the cost of cigarettes and many advertisements contain mandated health warnings. Thus, a ban of advertising could increase consumption by reducing prices or reducing awareness of health risks. The opposing or "public-health position" is that cigarette advertising and promotion have direct and indirect effects on smoking behaviors, such as inducing experimentation by children and young adults; encouraging increased consumption by smokers; undermining the motivation to quit; and encouraging former smokers to resume the habit (U.S. Surgeon General 1989). This view is reinforced by studies that examine the appeal of advertisements to young people, such as the controversy that surrounded the "Joe Camel" campaign (Fischer et al. 1991). Informal evidence for the public-health position is provided by before-after comparisons for countries that have adopted bans (Joossens 2000) and simple comparisons of groups of countries with and without complete bans of advertising (Lynch and Bonnie 1994; Saffer 2000).

Systematic tests of the effect of advertising bans are provided by three cross-national panel studies that examine annual data on cigarette consumption: Laugesen and Meads (1991); Saffer and Chaloupka (2000); and Stewart (1993). Results in these studies are less than convincing for two reasons. First, advertising bans could be endogenously determined together with cigarette consumption, but all previous studies treat advertising bans as exogenous. In order to avoid the potential bias associated with endogenous regressors, the present study estimates a structural equation for the enabling legislation that restricts advertising. Second, annual data on cigarette consumption by country contain pronounced negative trends, and the data series in levels are unlikely to be stationary. The present study tests for unit roots and uses log first-differences (consumption growth rates) to obtain stationary data series for a sample of 20 OECD countries. The first motivation for this study is that cross-national panel studies of advertising bans must account for econometric problems of endogeneity and stationarity before arriving at a verdict on the importance of advertising bans as tobacco control policies.

A second motivation is based on the following broad set of observations: by the mid-1970s the risks associated with smoking were well known and cigarette consumption began to decline sharply in many countries. Prior to that time, per capita consumption in most countries was either flat or declined modestly from the higher levels experienced in the 1960s and early 1970s. For example, per capita consumption in the United States increased to an all-time high in 1963 and declined modestly until about 1978. Between 1978 and 1995, consumption in the U.S. declined on average by -2.44% per annum. In the United Kingdom, the average rate of decline for the same time

[1] U.S. brand shares have changed substantially over time. In 1950, the three leading brands were Camel (market share of 27.2%), Lucky Strike (22.7%), and Chesterfield (17.9%). In 1995, the dominant brand was Marlboro (30.2%), followed by Newport, Winston, and Doral, with about 5.7% each. For discussion of strategic developments in the industry surrounding these changes, see Jaffee (2001), Jones (1997), and Miles (1982).

period was -3.16% per annum. Further, the decline in consumption was accompanied by reductions in smoking prevalence. In the U.S., male smoking prevalence declined from about 44% of the population in 1970 to 32% in 1985 and 26% in 1995, while in the U.K., smoking prevalence by males fell from 54% in 1970 to 34% in 1985 and 30% in 1995 (Forey et al. 2002). Moreover, female smoking prevalence has risen over time and offsets in part the decline in male prevalence. Smoking also is increasingly concentrated among individuals with lower incomes or lower levels of education (CDC 1994; Pierce 1989; Viscusi 2002a). Hence, changes in smoking prevalence and demographics suggest that the sample of smokers drawn from the population will not be homogeneous over time, which implies that empirical estimates may not be robust to the chosen time period or other aspects of the sample and model specification. While this issue has received some attention in previous work, this study examines structural change, first, by estimating a recursive coefficient model that demonstrates changes in income and price elasticities over time; and, second, by incorporating smoking prevalence and demographics as explanatory variables in a structural equation for advertising bans. Lastly, the quality of the data on cigarette consumption has been an issue in prior work, and some space in the paper is spent explaining the details of the data set and its construction.

The number of countries that have enacted comprehensive bans of cigarette advertising has grown steadily. Broadcast advertising was banned in all OECD countries by the early 1980s, except in Japan where it is still permitted. Although only three countries were early adopters, comprehensive bans of cigarette advertising had been enacted by 1995 in nine countries: Iceland (1972), Norway (1976), Finland (1978), New Zealand (1991), Italy (1992), Canada (1993), France (1993), Australia (1994), and Sweden (1995). Most of these bans follow, rather than predate, the decline in consumption that began in the late-1970s or early-1980s. Developed countries have generally followed a sequence of restrictions, commencing with bans of broadcast advertising and health warning requirements for packages. These restrictions are later supplemented by bans of cinema and billboard advertising as an intermediate stage, combined with stronger warnings in advertising and rotating warnings on packages. The final stage involves restrictions on print content and media, restrictions on shop advertising, sponsorship bans, and restrictions on indirect advertising such as prohibiting the use of brand names on apparel items. Overall, this sequence can be characterized by a set of binary dummy variables or, alternatively, by scoring the restrictions using a count of the number of banned media in each country. In contrast to previous studies, both dummy and count methods are examined and the count method is used in the structural model. Also, previous studies did not consider health warnings as a separate policy, and this policy variable is added in the present study.

The organization of the paper is as follows: Section 2 examines the methods and results in three previous panel studies. As a preliminary step, this section also tests for unit roots in the data series for per capita cigarette consumption and demonstrates that previous studies are based on non-stationary data series. Section 3 develops the two-equation model of cigarette consumption and advertising legislation, and describes the data and variables. Section 4 presents single-equation estimates for consumption for various model specifications and time periods, and tests for structural change in the cigarette demand function. Beginning around 1985, significant changes are demonstrated for price and income elasticities. Section 5 estimates the two-equation structural model using a recursive model structure and instrumental variables approach. A Poisson regression model is estimated for the adoption of advertising bans, with male and female smoking prevalence as explanatory variables. Fitted values from the adoption equation are used as instruments for advertising bans in the consumption equation. Section 6 summarizes the results and comments on the implications for public policy.

2. Previous Studies, Country Trends, and Unit Root Tests

Previous Studies

There is a substantial literature dealing with estimation of cigarette demand functions.[2] Three previous panel-data studies are most relevant to the empirical work in this paper. First, Laugesen and Meads (1991) examined a panel of 22 countries for the period 1960-1986. The countries were all members of the Organization for Economic Cooperation and Development (OECD). The dependent variable was annual grams of tobacco consumed per adult ages 15 and older. Explanatory variables in the final model were: (1) real price in 1980 U.S. dollars, obtained primarily from national accounts data on tobacco expenditures; (2) real per capita GDP; (3) manufactured cigarettes as a percent of total tobacco products; (4) female labor force participation; and (5) an advertising restriction score for manufactured cigarettes. Advertising restrictions were scored on a 10-point scale based on a count of banned media *and* health warnings required on packages and advertisements. The dependent variable and the price and income variables were transformed using logarithms. The model was estimated by GLS, but the exact econometric specification was not reported. Time-specific and country-specific dummies were not included, although some of the regressions included a common time trend. The trend variable was interacted with the variables for income, advertising, and female labor force participation, which yields coefficients that vary with time. Using the interaction model, the authors reported that advertising restrictions had small positive effects on consumption for 1960-1972, but thereafter the restrictions had small negative effects on consumption (Laugesen and Meads 1991, p. 1350). They attributed this change to better enforcement of the laws *and* to changes in the social climate. The price elasticity estimated by Laugesen and Meads was -0.189, while the income elasticity declined from 0.432 in 1960 to 0.174 in 1986. Two problems with this study are that it combines health warnings with advertising bans and the trend variable could easily capture other time-varying effects such as health concerns and social climate, which are transmitted to the advertising coefficient. Stewart (1993) criticized this study for accuracy of the consumption data and for excluding country-specific dummies, among other things.

A second panel study was conducted by Stewart using a sample of 22 OECD countries for the time period 1964-1990. Six countries had by 1990 introduced comprehensive restrictions of tobacco advertising, although several were less than complete bans. The dependent variable in this study was annual grams of tobacco per adult, which was regressed on explanatory variables for the real price, percent elderly population, country-specific time trends, country-specific dummies, and the advertising dummy for comprehensive restrictions. Income was omitted from the final model. Using pooled data, a nonlinear multiplicative model was estimated. Some of the parameters (price, time trend) were first estimated separately using the individual country time-series data and the coefficient estimates were used as extraneous information in the pooled regression (Stewart 1993,

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[2] For surveys of the cigarette demand literature, including advertising and rational addiction models, see Andrews and Franke (1991), Cameron (1996, 1998), Chaloupka and Warner (2000), Duffy (1996), Gallet and List (2002), Simonich (1991), and Viscusi (1992). See also Hamilton (1977) for pooled cross-national regressions for 1948-1973, and Cox and Smith (1984) and McLeod (1986) for before-after time-series studies by country.

pp. 159-60). The final model was estimated by weighted least-squares using the square root of each country's population and the results were corrected for serial correlation. The price elasticities ranged from -0.16 for Spain to -0.83 for Switzerland, with a median value of -0.35 and a mean elasticity of -0.31. Stewart (1993, p. 165) found that the advertising ban dummy was positive and not statistically significant during 1964-1990. Saffer and Chaloupka criticized the consumption data used in Stewart's study, which are derived in part from the OECD expenditure data and typical retail prices provided by industry sources.

The third panel study was conducted by Saffer and Chaloupka (2000). They used a data set produced by Health New Zealand Ltd. (HNZ).[3] The sample covered 22 OECD countries for the time period 1970-1992. Two dependent variables were considered: annual per capita consumption of cigarettes (number of pieces assuming one cigarette weighs one gram); and annual per capita consumption of tobacco (expressed in grams). A logarithmic transformation was not used. The explanatory variables were the real price, real GDP per capita, percent of cigarettes that are filtered, and the unemployment rate. Two binary dummies measured the number of media banned in a country: *limited bans* (3 or 4 media banned); and *comprehensive bans* (5 to 7 media banned). The null category was *weak bans* (0 to 2 media banned), which includes the broadcast media (TV and radio). Saffer and Chaloupka regressed per capita consumption (in levels) on the explanatory variables (in levels) and time and country fixed-effects dummies. As a result, the advertising estimates are based on the within-country time variation that remains after accounting for the influence of the other variables and a common set of time trends. However, the advertising dummies were not always significant, and the authors experimented with regressions covering the time periods 1970-1992, 1984-1992, and several shorter periods down to 1987-1992. For 1970-1992, the dummies for limited bans had t-statistics ranging from -1.07 to +1.43, and the comprehensive-ban dummies had t-statistics ranging from -0.76 to +2.08 (Saffer and Chaloupka 2000, p. 1129). When the model was re-estimated for 1984-1992, the dummy for comprehensive bans was significant and negative in all four of the reported regressions. These estimates appear to be based on data for only three countries that adopted comprehensive bans during 1972-1978: Finland, Iceland, and Norway. Further, the limited-ban dummies failed tests of significance until the sample was 1986-1992. These estimates capture the strong decline in cigarette consumption beginning in the 1980s, regardless of changes in advertising legislation.

The results in Saffer and Cahloupka are suggestive of structural change in the demand for cigarettes, which is not explicitly examined in their study. There is no convincing reason why comprehensive bans should be completely ineffective prior to 1984, given that the estimates are based on within-country variation. It is equally likely that the results capture changing social attitudes or other time-varying aspects of the data. Although the authors include time fixed-effects, this imposes a common time trend on each country. Their specification ignores the diversity of trends across countries (see below) as well as the prior work on time-varying coefficients. It seems likely the Saffer and Chaloupka's results are spurious, reflecting the shortcoming of non-stationary data and structural change in the demand for cigarettes.

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[3] The Health New Zealand Ltd. data set is proprietary, and includes information on consumption, price, income, health warnings, advertising bans, and demographics (http://www.healthnz.co.nz). Saffer and Chaloupka did not use the available HNZ data on warning messages in their empirical work. I have used the HNZ data set for advertising bans and warnings messages, updated to 2002 (HNZ 2002). Except for these data, the remainder of the data set developed for the present study uses publically available data.

Advertising-Response Function

Saffer and Chaloupka used a S-shaped advertising-response function to explain the empirical results and motivate policy conclusions. In Figure 1, schedule A1 is the Saffer-Chaloupka advertising-response function, which reflects increasing and decreasing marginal returns. The results in the present study are consistent with schedule A2, which illustrates diminishing returns to advertising and saturation of the market after limited exposures (for supporting evidence, see Andrews and Franke 1991; Little 1979; and Simon and Arndt 1980).

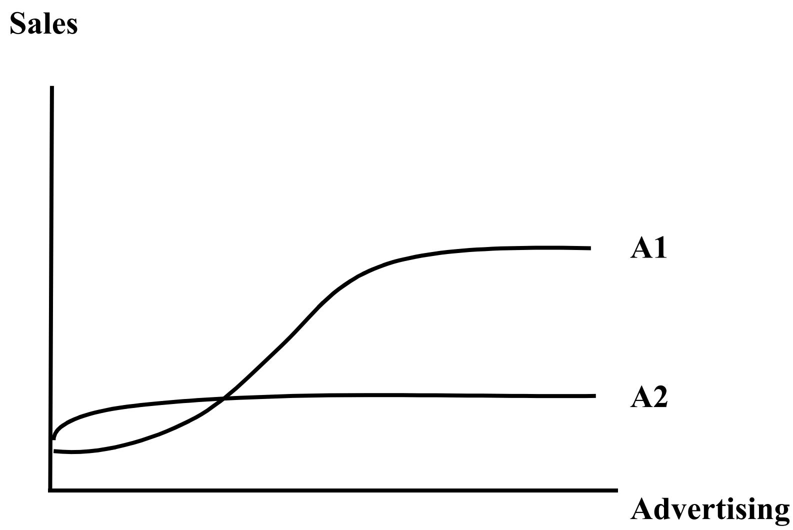


Figure 1. Advertising-Sales Response Functions

Country Trends

In order to document temporal changes in cigarette consumption, Figure 2 displays the trend in per capita consumption of total cigarettes (manufactured plus hand-rolled) in four OECD countries during the time period 1970-1995: Australia, Sweden, United Kingdom, and United States. Also displayed is the annual growth rate of per capita consumption expressed as a percent (log first-difference multiplied by 100). Advertising laws did not change importantly between 1977 and 1991 in any of these countries, but several things are noticeable in the graphs.[4] First, cigarette consumption in the U.K. and U.S. declined from about 1975 onward and there was an acceleration of the rate of decline around 1982. Second, consumption in Australia and Sweden remained stable until about 1982, and decreased sharply thereafter. The consumption trend in Australia and Sweden is characteristic of many OECD countries. Third, the data series in levels do not appear to share a common trend value. The growth rate plots *suggest* data series that are stationary around negative means for each country (the means are -1.33%, -1.32%, -2.42%, and -1.77%, respectively). It is well known that OLS regressions performed on non-stationary data series can yield spurious results unless the trend is removed by direct subtraction or by differencing (Enders 1995). The ad hoc procedures followed in Saffer and Chaloupka might yield stationary series, although formal tests for the data or residuals are not reported. For example, it might be that shortening the time period to 1984-1992 yields a sample containing more countries with similar trends, although this possibility is not developed formally in their study. Instead, Saffer and Chaloupka conclude that their results must in some way reflect the cumulative impact of advertising restrictions and increasing returns to advertising, rather than changes occurring in the underlying data-generating process.

Figure 3 displays consumption trends and growth rates in four additional countries, including the three countries that adopted advertising bans in the 1970s. Canada and Iceland illustrate declining consumption beginning in 1982 and 1985, respectively. Iceland adopted comprehensive advertising bans in 1972, but Canada waited until 1993. The patterns are less clear in Finland and Norway, despite comprehensive advertising bans adopted in 1978 and 1976, respectively. Again, a diversity of trend values is apparent in the graphs.

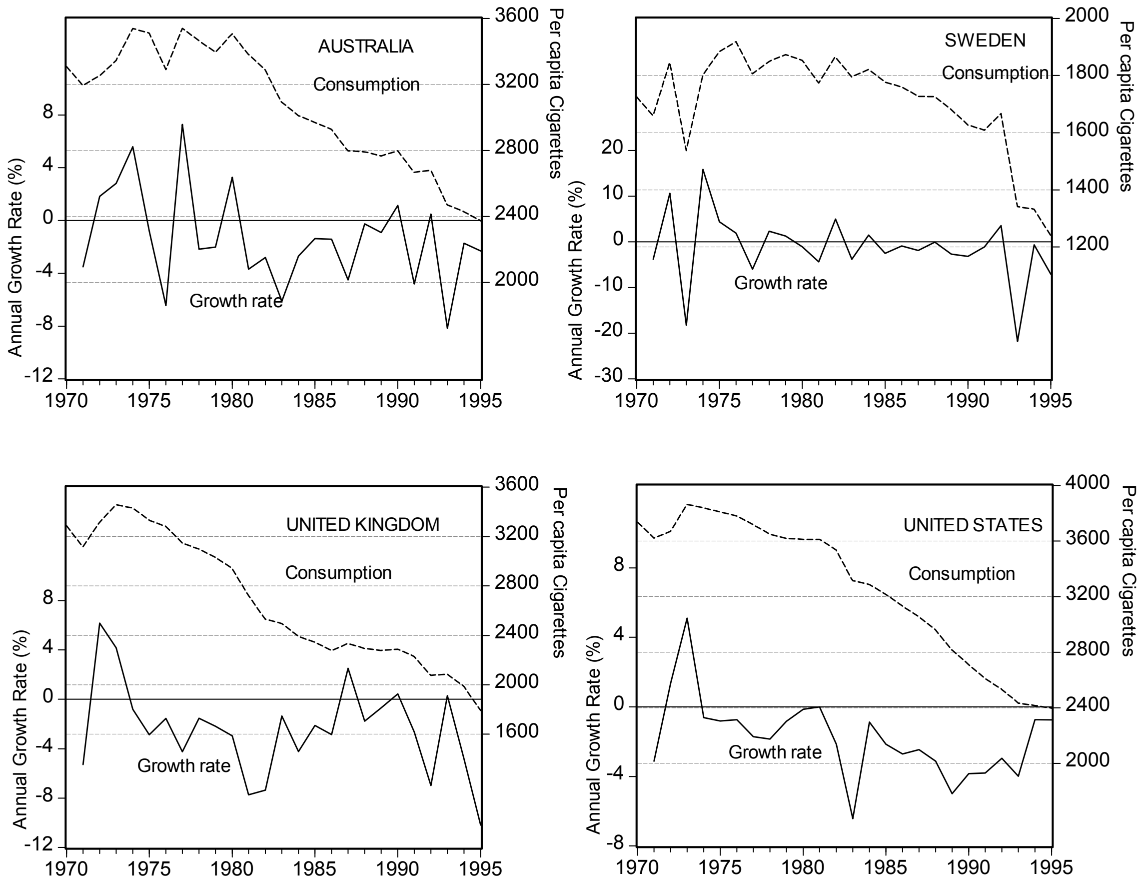
Unit Root Tests

As a preliminary step in the analysis, I tested each consumption series for unit roots. The consumption series includes both manufactured cigarettes and estimates of hand-rolled cigarettes.[5] Table 1 reports the results of Dickey-Fuller (D-F) tests using two data series: annual per capita consumption in levels for 1970-1995; and the annual percentage growth rate of consumption for 1971-1995. For the levels data, tests are conducted with and without a country-specific time trend in the D-F test equation. Among the 20 countries, only Japan is trend stationary in levels and Norway is stationary around a constant. In contrast, all of the growth rate series are stationary at the 5% confidence level or better. Further, the estimated trend coefficients (column 3) are substantially different, ranging from large negative trends for the Netherlands and New Zealand to a significant positive trend for Portugal. The positive trends for Greece, Portugal, and Spain reflect

[4] Prior to 1970, Sweden had bans of television, radio, and cinema ads; it placed a ban on billboards in 1975; and added restrictions on print ads in 1995. Australia banned television and radio ads in 1976; it placed restrictions on print and cinema ads in 1991; and added a ban of billboards in 1994. The U.S. banned television, radio and cinema ads in 1971, while the U.K. had a ban of television and radio ads prior to 1970 and it added a ban of cinema ads in 1987 (HNZ 2002). Hence, there was only one minor change during 1977-1991.

[5] Hand-rolled cigarettes are important in some countries, including Belgium (35% of cigarettes in 1995), Denmark (25%), Netherlands (46%), New Zealand (16%), and Norway (46%). In other countries, hand-rolled consumption is 0-10% (Forey et al. 2002). It is unclear how previous studies have handled this coverage issue.

Figure 2. Consumption Levels and Growth Rates:
Selected Countries



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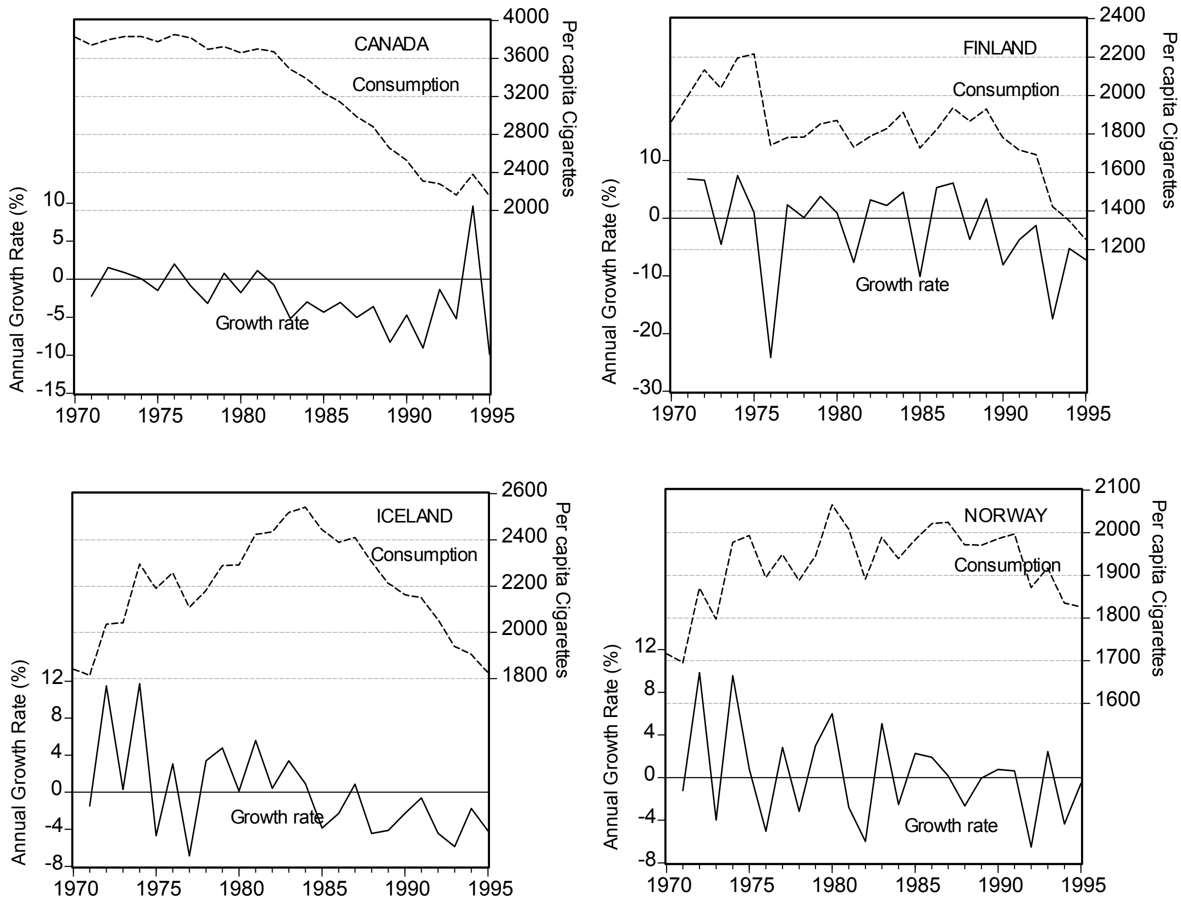

Table 1 – Unit Root Tests for Data in Levels and Log Differences, 1970-1995

Country	Levels Model	DF Test Statistic [trend value]	Levels Model	DF Test Statistic	Log-Diff Model	DF Test Statistic
Australia	C,T,L	-1.976 [-14.6**]	C,L	0.314	L	-4.837*
Austria	C,T,L	-1.175 [-6.04*]	C,L	0.262	L	-4.635*
Belgium	C,T,L	-2.222 [-16.1**]	C,L	-0.821	L	-3.884*
Canada	C,T,L	-1.710 [-16.3**]	C,L	1.024	L	-3.817*
Denmark	C,T,L	-2.452 [-5.24**]	C,L	-1.170	L	-5.983*
Finland	C,T,L	-2.208 [-12.5**]	C,L	-0.606	L	-4.925*
France	C,T,L	-1.299 [-2.85**]	C,L	-0.965	L	-4.430*
Greece	C,T,L	-2.192 [5.28]	C,L	-2.206	L	-5.267*
Iceland	C,T,L	-0.880 [-6.83**]	C,L	-1.197	L	-4.946*
Ireland	C,T,L	-1.995 [-13.5**]	C,L	-0.397	L	-2.916*
Italy	C,T,L	-1.343 [-5.05*]	C,L	-1.838	L	-2.857*
Japan	C,T,L	-4.174** [-6.09*]	C,L	-2.948	L	-2.872*
Netherlands	C,T,L	-3.243 [-27.3*]	C,L	-1.028	L	-6.228*
New Zealand	C,T,L	-2.008 [-21.5**]	C,L	0.999	L	-4.149*
Norway	C,T,L	-2.626 [-0.66]	C,L	-3.086**	L	-7.167*
Portugal	C,T,L	-2.597 [10.1**]	C,L	-1.691	L	-3.977*
Spain	C,T,L	-2.118 [2.05]	C,L	-2.504	L	-6.327*
Sweden	C,T,L	-1.845 [-8.34**]	C,L	-0.725	L	-7.327*
United Kingdom	C,T,L	-1.989 [-19.1**]	C,L	0.403	L	-2.448**
United States	C,T,L	-2.063 [-14.4**]	C,L	1.213	L	-2.413**
Mean DF stat		-2.106		-0.798		-4.570*

Notes: Dickey-Fuller (DF) test equation includes: C = constant term; T = time trend; and L = one lagged dependent variable. Asterisks indicate rejection of null hypothesis of a unit root. With 25 and 24 observations, critical values at the 1% (5%) confidence level are: C,T,L model = -4.374 (-3.603); C,L model = -3.720 (-2.985); and L model = -2.665 (-1.956). The trend coefficients in brackets are significantly different from zero at the 1% level (*) or 5% level (**) based on a standard t-test. Using an augmented DF test with one lagged difference resulted in rejection of the null at the 5% level for the C,T,L model for only the United Kingdom and United States. The mean DF statistics can be evaluated using the Im, Pesaran, Shin (2002) test for unit roots in panel data. Critical values for the test are -2.62 (-2.48) for the C,T,L model and -1.99 (-1.85) for the C,L and L models.

increases in female smoking prevalence. In general, empirical work performed on the levels data requires careful consideration of the diversity of trends across countries as well as the non-stationarity of consumption in most countries.[6] It is unclear if the procedures used in previous panel studies are adequate in this regard. The present study estimates panel data models using stationary data and examines changes in the structure of demand that generates the consumption series.

3. Consumption-Advertising Ban Model and Data

The econometric model developed in this section consists of two structural equations: one equation for cigarette consumption and a second for the adoption of advertising restrictions. In the empirical work, two sets of estimates are provided. First, in order to obtain comparisons with previous studies and to examine the changing structure of demand, single-equation panel estimates are provided for the consumption equation, with advertising bans treated as exogenous variables. Second, a two-equation recursive model of consumption and advertising bans is estimated by instrumental variables (IV). One equation explains the growth of consumption as a function of economic and regulatory variables (prices, income, warnings, advertising bans) and the second equation uses a public-choice framework to model the adoption of stronger advertising legislation. In the adoption equation, the dependent variable is a count of the number of banned media. Explanatory variables for male and female smoking prevalence capture the political importance of smokers in each country and additional variables reflect other special interests, such as healthcare concerns, cigarette tax revenues, and demographic factors.

Model

Let $CIGGRO_{it} = log(CIG_{it}) - log(CIG_{it-1})$ denote the growth rate of per capita consumption, where CIG_{it} is per capita cigarette consumption in the i-th country in year t. Let $PREV_{it}$ represent smoking prevalence in the population expressed as a percent, which is both a component of CIG_{it} and an explanatory variable. Finally, let BAN_{it} represent a count of the number of banned media, which is hypothesized to be endogenous in the consumption equation. A two-equation recursive model of consumption and advertising bans is given by:

$$(1) \qquad CIGGRO_{it} = BX_{it} + B_B \bullet BAN_{it} + F_i + \left(e_{it} + \lambda \bullet u_{it}\right)$$

$$(2) \qquad BAN_{it} = G\left(CZ_{it}, C_P \bullet PREV_{it}, F_i\right) + u_{it}$$

where B, C are vectors of coefficients associated with the exogenous causal vectors X and Z, respectively; B_B and C_P are coefficients for the BAN and $PREV$ variables; F_i are country fixed-effects dummies; e_{it} and u_{it} are stochastic disturbances; and G represents the Poisson estimator for the

[6] For more on unit roots and non-stationarity in cigarette time-series data, see Cameron (1996), Cameron and Collins (1997), and Reinhardt and Giles (2001).

adoption equation.[7] The error term in equation (1) has two components: e_{it} is the error due to all random changes that are unrelated to advertising bans; and $\lambda \bullet u_{it}$ is the error component due to the stochastic regressor *BAN*. The correlation between *BAN* and the disturbance term in (1) could be small, but it is not assumed away as in previous studies. Hence, if *BAN* is correlated with the error term in equation (1), this necessitates its treatment using instrumental variables. The feedback from *BAN* to *PREV* is assumed to be slow or weak, such that the prevalence component of *CIG* can be treated as exogenous in equation (2). Country fixed-effects, F_i, are used to account for omitted or unmeasurable factors and appear as different intercepts for each country. In equation (1), the fixed-effect coefficient multiplied by 100 is the country's exogenous growth rate of cigarette consumption and reflects, among other things, socio-economic factors that change gradually over time or which are difficult to capture in an explicit manner for a cross-section of countries, e.g., schooling, smuggling, and social attitudes toward smoking. The log-difference transformation makes it unnecessary to include time fixed-effect dummies in equation (1).

The adoption equation (2) explains the changing political environment for the tobacco industry. In this equation, regressors for male and female smoking prevalence are treated as exogenous in the adoption equation. Conventionally, cigarette consumption per capita is measured by deflating by the entire adult population. Hence, per capita consumption reflects cigarettes consumed per smoker and smoking prevalence in the population as a whole. Gradual changes in smoking prevalence combined with infrequent changes in advertising legislation suggest little in the way of a strong contemporaneous response of smoking prevalence to the number of bans. A Hausman test of this condition is reported below. The IV estimates of the model are obtained by, first, estimating equation (2) for advertising bans using a Poisson regression on the count of the number of banned media. Fitted values from the adoption equation are used as instruments in equation (1).

Consumption and Prevalence Data

Following previous studies, a panel data set was constructed for tobacco consumption and advertising bans for 20 OECD countries for the period 1970-1995.[8] The explanatory variables in the consumption growth equation include the real price, real income, a dummy variable for health warnings, and several dummy variables for advertising restrictions. Alternatively, the advertising dummies are replaced by an integer count of the number of media banned in each country. Data by country were collected on the following additional variables: adult population (ages 15 and older), elderly population (ages 65 and older), GDP per capita, GDP deflator, purchasing power parity, tobacco expenditures, openness of the economy, healthcare expenditures, unemployment rate, cigarette tax revenues, percent cigarettes with filters, and smoking prevalence of males and females.

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[7] The Poisson regression model imposes the restriction that the variance of the data equals the mean, conditional on the explanatory variables. A regression-based test of this equality is found in Cameron and Trivedi (1990). Application of their test to the results reported in Table 5 (below) indicated a small, but significant, underdispersion in the data. However, estimation of the negative binomial model gave poorer results based on both the Akaike information criterion and the standard error of the regression. Estimation of a Tobit model, with right and left censoring, yielded better results for the information criterion and standard error, but at the cost of a number of significant negative values for the country fixed-effects coefficients. Overall, the advantages of the Poisson count model appear to outweigh its possible disadvantages.

[8] Switzerland is omitted due to a lack of cigarette expenditure data and Germany is omitted due to the break in the data series following reunification in 1990. It is unclear how previous studies handled these problems.

This information is used to construct the variables in the consumption equation or included in the structural equation for advertising legislation. Country-specific dummy variables are included in the consumption and adoption equations to account for the deterministic portion of the consumption growth rates and advertising bans, respectively.

Table 2 lists all variables and data sources used in the present study, including the variables described in this section or which appear below in the adoption equation. The data on cigarette and tobacco consumption were obtained from *International Smoking Statistics* (Forey et al. 2002). This comprehensive source includes estimates of sales in each country for manufactured cigarettes, hand-rolled cigarettes, and total consumption by weight of all tobacco products. The data series begin around 1948 and extend to 1995. The present study focuses on total cigarettes, defined as the sum of manufactured and hand-rolled cigarettes for 1970-1995. Adjustments are made in *Smoking Statistics* for smuggling, cross-border sales, inventories, and changing weight of a cigarette (Forey et al. 2002, p. xxxii).[9] As a population deflator, I used the adult population estimates found in *OECD Health Data 2001* (OECD 2001b). Given these data, several different dependent variables for consumption growth are possible, including: (1) annual per capita consumption of total cigarettes, averaged over the adult population; (2) per capita consumption of manufactured cigarettes; (3) per capita consumption of tobacco by weight (grams); and (4) per capita consumption of total cigarettes by smokers, averaged over the estimated smoking population. The study focuses on the growth rate of total cigarettes per capita, with selective results reported for the other variables. For each country, *Smoking Statistics* also summarizes numerous survey estimates of smoking prevalence for males and females. In most cases, the data on prevalence begin in 1975 and extend to 1995, but estimates are not available for every year. Prevalence data for the intervening years were obtained by linear interpolation, which should not create significant measurement errors based on gradual changes in prevalence of smoking.

Cigarette Prices

Data series for real cigarette prices were developed using the *OECD Health Data 2001* (OECD 2001b) as the main source, which reports tobacco expenditures for 1960-1995 in national currency units. Additional expenditure data for a few recent years were obtained from the *National Accounts of OECD Countries, Volume II: Detailed Tables for 1970-1999* (OECD 2001a). Expenditure data were missing for Japan for 1970-1976 and New Zealand for 1970-1979. I assumed that real total expenditures did not change during the missing years compared to 1977 and 1980, respectively. The price estimates for all countries were converted to constant values by deflating by the GDP deflator for each country (1995 = 100). The resulting series were converted to U.S. dollars per pack by dividing by the purchasing power parity (PPP) for each year and by total consumption in packs of 20 cigarettes. The source for the GDP deflator and PPP index is the *National Accounts* report (OECD 2001a).

Purchasing power parity is the number of national currency units per U.S. dollar required for a given market basket, including taxes. The OECD computes PPP for several hundred products using several benchmark years: 1980, 1985, 1990, 1993, and 1996. PPP for intervening and earlier

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[9] Forey et al (2002) makes selective adjustments for smuggling and bootlegging. Merriman et al. (2000, p. 379) estimate that only 3% of European consumption during 1989-1995 was due bootlegging. They also conclude that about 6% of consumption worldwide is smuggled.

Table 2 – Variables and Data Sources

Variable	Definition (Source)	Notes
Total Cigarettes	Annual per capita consumption of cigarettes in pieces (manufactured plus hand-rolled) for population ages 15 years and older (Forey et al. 2002, Table 2). Population data from OECD (2001b).	Other variables for mfg. cigs. and tobacco by wt.
BAN-COUNT	Count of number of banned media for cigarette advertising (Health New Zealand 2002).	Range is 0 to 9 banned media
Income	Per capita GDP in 1996 U.S. dollars (Heston, Summers, and Alten 2002; on-line version for constant price measure, rgdpl).	*Penn World Table Version 6.1*
Price	Price per pack in 1995 U.S. dollars (OECD 2001a, 2001b).	See details in text
WARNING	Binary variable equals one for strong warning labels on packages and in advertisements (Health New Zealand 2002).	0-1 dummy
TV-RADIO	Binary variable equals one for ban of broadcast cigarette advertising on TV and radio (Health New Zealand 2002).	0-1 dummy
MODERATE	Binary variable equals one for bans of 3 or 4 media (Health New Zealand 2002).	0-1 dummy
STRONG	Binary variable equals one for bans of 5 or more media (Health New Zealand 2002).	0-1 dummy
Unemployment Rate	Unemployment rate expressed as a percent obtained from various editions of the OECD, *Labour Force Statistics*.	
Percent Filter	Percent of manufactured cigarettes sold with filters (Forey et al. 2002).	Table 3 in Forey
Prevalence	Prevalence of smoking by gender as a percent of the population ages 15 years and older (Forey et al. 2002, Table 8).	Male and female prevalence rates
Healthcare Cost	Total expenditures on health as a percent of GDP (OECD 2001b).	
Lagged Tax Revenue	Tobacco tax revenues as a percent of household tobacco expenditures, lagged one year (OCED 2001b).	Lagged variable
Pop > 65 yrs	Percent of population ages 65 years and older (OECD 2001b).	
Openness Index	Imports plus exports as a percent of GDP (Heston, Summers, and Alten 2002; current price measure, openc).	*Penn World Table Version 6.1*

Notes: All data are for 1970-1995 for 20 OECD countries: Australia, Austria, Belgium, Canada, Denmark, Finland, France, Greece, Iceland, Ireland, Italy, Japan, Netherlands, Norway, Portugal, Spain, Sweden, United Kingdom, and United States.

years is interpolated based on inflation rates in the respective countries relative to the U.S. rate. However, countries with high inflation rates tend to present a misleading picture of individual prices relative to the U.S., and unrealistic values for cigarette prices were obtained for Iceland and Greece during the 1970s and early 1980s. A solution to this problem is to assume that the relative price of cigarettes is constant compared to one benchmark year. The real price of cigarettes for Iceland and Greece are calculated using the PPP for 1995 as the deflator for all earlier years. Across all countries, the common pattern is a gradual decline in real prices to some point in the mid-1980s, and a rise thereafter. Real cigarette prices in 1995 compared to 1985 were higher in 19 of 20 countries (Portugal is the exception), and the estimated price series for Iceland and Greece follow this common pattern. The use of logged differences avoids errors in the price levels. Given its construction, the price variable is likely to be correlated with the error term in the demand equation. Results of a Hausman endogeneity test are reported for the price variable for two time periods, 1971-1984 and 1985-1995.

Real Income per Capita

Following previous panel studies, income is measured by real per capita GDP in U.S. dollars. The data source for these estimates is the *Penn World Table Version 6.1* (Heston, Summers, and Aten 2002).

Advertising Bans and Health Warnings

Regulatory information on advertising bans and health warnings were obtained from Health New Zealand's *International Tobacco Control Database* (HNZ 2002), which uses as a primary source the *International Digest of Health Legislation* (WHO 1960-2002). For each country and year, HNZ reports the media in which cigarette advertising are banned. Nine media are covered, including television, radio, cinema, outdoor, newspapers, magazines, shop ads, sponsorships, and indirect advertising such as brand names on non-tobacco products. Based on these data, three advertising dummy variables were defined: TV-RADIO (= 1 if only television *and* radio are banned, zero otherwise); MODERATE (= 1 if 3 or 4 media are banned); and STRONG (= 1 if 5 or more media are banned). Saffer and Chaloupka (2000) considered only MODERATE and STRONG in their empirical study, whereas my specification attempts to account for the *type* of media banned (broadcast only vs. other media) as well as the *number* of media banned. In addition, a variable called BAN-COUNT was created, which is an integer count of the number of banned media. Empirical results are reported for both dummy and count specifications. In addition, HNZ reports the regulations for health warnings in advertisements and on packages. For example, package warnings are regarded as "strong" if rotating warnings are required. A dummy variable for strong warnings, denoted by WARNING, equals one if the HNZ index for warnings had a value of two or more. Saffer and Chaloupka (2000) did not include a warning variable.

The HNZ data demonstrate how the restrictiveness of cross-national advertising legislation has increased steadily over time. The sample means (std. dev.) for BAN-COUNT for 1970-1995 at five-year intervals are: 0.9 (1.3); 1.8 (1.8); 2.6 (2.2); 3.3 (2.2); 3.8 (1.9); and 4.6 (2.2) in 1995. On average, 4 to 5 media were banned in the 1990s compared to only 1 or 2 in the 1970s. Except for Austria, Japan and Spain, all OECD countries by 1995 had enacted moderate or strong bans of cigarette advertising. In 1995, there were 9 countries in the STRONG category, compared to 5 in 1990; 4 in 1985; and only 3 countries in 1980 and earlier. For health warnings, the number of countries with strong warnings increased from 4 in 1980 to 6 in 1985; 11 in 1990; and 18 countries in 1995. Austria and Japan are the exceptions in 1995. For several reasons, Japan is a possible outlier and some results are reported without Japan in the sample. Because broadcast bans were adopted by 1985 in all countries except Japan, it is appropriate to omit TV-RADIO from regressions based on time periods after 1985.

4. Cigarette Demand and Structural Change

This section presents single-equation estimates of cigarette demand functions that parallel the estimates reported by previous cross-national panel studies. Advertising bans are treated as exogenous. Regression estimates in levels and growth rates are presented for different time periods and econometric specifications. I also report Durbin-Watson statistics by country. In order to obtain recursive coefficient estimates, one of the growth rate regressions is selected and estimated recursively using successively smaller subsets of the data from 1970-1995 down to 1991-1995. Plots of the recursive coefficients indicate a structural break in about 1985, which is confirmed formally by Wald and Chow tests.

Advertising Dummy Variables

Table 3 shows the first set of estimates. Regressions (1)-(3) use total cigarette consumption in levels as the dependent variable, while the other four regressions use the log-difference growth rate specification. Regressions (1)-(6) report t-statistics based on robust estimates of the standard errors. Regression (7) is estimated by GLS using the cross-section residual variances. Regressions (1)-(3) include time fixed-effects in order to replicate methods employed by Saffer and Chaloupka. In regression (1), estimation of the levels model yields a significantly negative effect of STRONG for 1970-1995, but the estimate is not robust to modest changes in the specification or shortening of the time period as shown in regressions (2) and (3). TV-RADIO is significantly positive. In levels form, the price coefficient is significantly negative and the percent filter coefficient is significantly positive. Excluding Japan from the sample rendered the coefficient on STRONG insignificant for 1970-1995, and did not change the other results substantially.

Regressions (4)-(7) show the empirical results using growth rates. The results indicate that cigarette consumption is determined by income, price, and exogenous country-specific factors. The advertising dummies are never significantly negative. Percent filter and the unemployment rate are not significant when demand is expressed as a growth rate. The income elasticity is significantly positive and the price elasticity is significantly negative. The income elasticity is about 0.21. The price elasticity is about -0.39, which is identical to the consensus estimate of -0.4 for aggregate data as reported by Chaloupka and Warner (2000, p. 1548). The intercept values for the United Kingdom and United States illustrate the significant differences that exist among the exogenous trends for each country, conditional on the other explanatory variables in the growth rate model.

Serial Correlation

Using regressions (1) and (5), I examined each country's residuals for serial correlation. For regression (1) with 25 observations and nine regressors, the mean Durbin-Watson (D-W) statistic was only 0.520, averaged over the 20 countries. The D-W test indicated positive autocorrelation for 16 countries and the other four countries were in the inconclusive range (Denmark, Iceland, Netherlands, Sweden). Using regression (5), the mean D-W value was 2.167 and 13 countries had

Table 3 – Levels and Growth Rate Regressions: Cigarette Consumption per Capita

Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Dep. Variable	Levels	Levels	Levels	Log Diff	Log Diff	Log Diff	Log Diff
Income (linear & log diff.)	0.040 (1.70)	0.043 (1.95)	0.080 (4.99)*	0.212 (3.64)*	0.213 (3.67)*	0.221 (3.82)*	0.189 (3.80)*
Price (linear & log diff.)	-109.4 (8.05)*	-102.3 (7.67)*	-307.8 (6.95)*	-0.387 (9.24)*	-0.386 (9.11)*	-0.391 (9.89)*	-0.347 (19.9)*
WARNING packs & ads (dummy)	-78.31 (1.81)	-54.85 (1.29)	56.05 (1.81)	0.010 (1.45)	0.009 (1.34)	0.008 (1.13)	0.007 (1.65)
TV-RADIO (ban dummy)	---	194.9 (3.62)*	---	---	-0.003 (0.41)	---	---
MODERATE (ban dummy)	-86.77 (1.62)	45.86 (0.69)	-60.23 (1.62)	0.007 (0.93)	0.005 (0.51)	0.006 (0.77)	0.005 (1.01)
STRONG (ban dummy)	-134.0 (2.11)*	16.86 (0.23)	-101.0 (1.94)	0.001 (0.07)	-0.002 (0.16)	-0.001 (0.07)	-0.005 (0.71)
Unemployment Rate (linear)	-0.753 (0.10)	-2.435 (0.34)	15.24 (2.23)*	-0.001 (0.10)	-0.001 (0.04)	---	---
Percent Filter (linear)	9.469 (4.14)*	9.552 (3.93)*	6.875 (2.26)*	-0.001 (0.88)	-0.001 (0.72)	---	---
UK Intercept value	2165 (7.02)*	1970 (6.32)*	1397 (2.93)*	-0.025 (1.16)	-0.025 (1.18)	-0.045 (4.80)*	-0.043 (6.49)*
USA Intercept value	2266 (4.97)*	2109 (4.72)*	821.2 (1.51)	-0.009 (0.44)	-0.010 (0.50)	-0.028 (2.61)*	-0.027 (4.18)*
R-sq (unwt)	0.841	0.847	0.957	0.476	0.476	0.474	0.469
F-stat	48.62	49.74	113.0	16.50	15.87	17.86	22.35
Heterosced. Adj	White	White	White	White	White	White	Wt. LS
Ctry Fix Effect?	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Fix Effect?	Yes	Yes	Yes	No	No	No	No
Time Period	70-95	70-95	85-95	71-95	71-95	71-95	71-95
No. of Obs	520	520	220	500	500	500	500

Notes: Dependent variables are levels for total cigarettes and its log first-difference. Linear versions of income and price are used in (1)-(3), and log differences in (4)-(8). T-statistics in parentheses are based on White's heteroscedastic-consistent estimate of the standard errors. Asterisks indicate significance at the 95% level. All regressions include 20 dummies for the OECD countries. See text and Table 2 for definition of variables, data sources, and list of countries.

values greater than 2.0. Although several countries were in the inconclusive range, the null of non-autocorrelated disturbances was never rejected. For example, the D-W statistic for the U.S. was 0.236 using regression (1) and 2.224 using regression (5). In general, the use of levels data on cigarette consumption results in serious downward bias in the standard errors, which might lead investigators to conclude that advertising bans are effective policies. Other econometric approaches are clearly required to examine the robustness of policy results obtained from levels data.

Advertising Ban Counts

Table 4 shows a second set of estimates for the growth rate model. Regressions (1)-(3) replace the advertising dummies with the count of banned media, BAN-COUNT. Regressions (4)-(8) use different dependent variables and the advertising dummies. Three time periods are examined, but BAN-COUNT is very small and never statistically significant. Shortening the time period has the effect of reducing the income elasticity and increasing the price elasticity.[10] Using manufactured cigarettes as the dependent variable has the effect of increasing the income and price elasticities, which is consistent with perceived higher quality of manufactured cigarettes and the narrower category of defined-use. Using tobacco weight as the dependent variable reduces the income and price elasticities, reflecting a broader category of tobacco use. Using cigarettes per smoker as the dependent variable adjusts for differences in smoking prevalence across countries and over time. This change renders the income elasticity insignificant. Conditional on smoking, the results suggest that income is not important for the number of cigarettes smoked, but price is important. Comparing regression (6) in Table 3 with regression (8) in Table 4, the price elasticities are -0.391 and -0.366, respectively. None of the advertising or warning variables in Table 4 are statistically significant, regardless of the dependent variable or time period.

Structural Change and Elasticities

Using regression (6) in Table 3, I next estimated a moving-regression version of the growth model in order to examine the stability of the coefficients (Brown, Durbin, and Evans 1975). Starting with 1971-1995, the time period was shortened by one year for each successive regression down to 1992-1995, which yields 22 estimates of each coefficient. Plots of the coefficient values and confidence intervals are displayed in Figure 4. Up to 1985, the income and price elasticities are about 0.2 and -0.4, respectively. Thereafter, the income elasticity decreases in value and is not statistically significant, which suggests that the cohort of smokers is different after 1985. The price elasticity increases steadily in absolute value and its terminal value is -0.621. All of the price elasticity estimates are negative and significant.[11] As discussed in the data section, real prices for cigarettes

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[10] I tried estimating regressions (1)-(3) including the variables for elderly population, openness index, and healthcare expenditures. These variables were not significant and did not change the other results. I also ran a Hausman test for price endogeneity, with lagged price, openness index, unemployment, percent filter, and time- and country-dummies as exogenous variables. With the residuals in levels, the test rejected the null for 1971-1984, but not for 1985-1995. In both cases, the results for BAN-COUNT were unaffected. Given the focus on the more recent time period, the price elasticities for the earlier period are biased toward zero, although the effect is small.

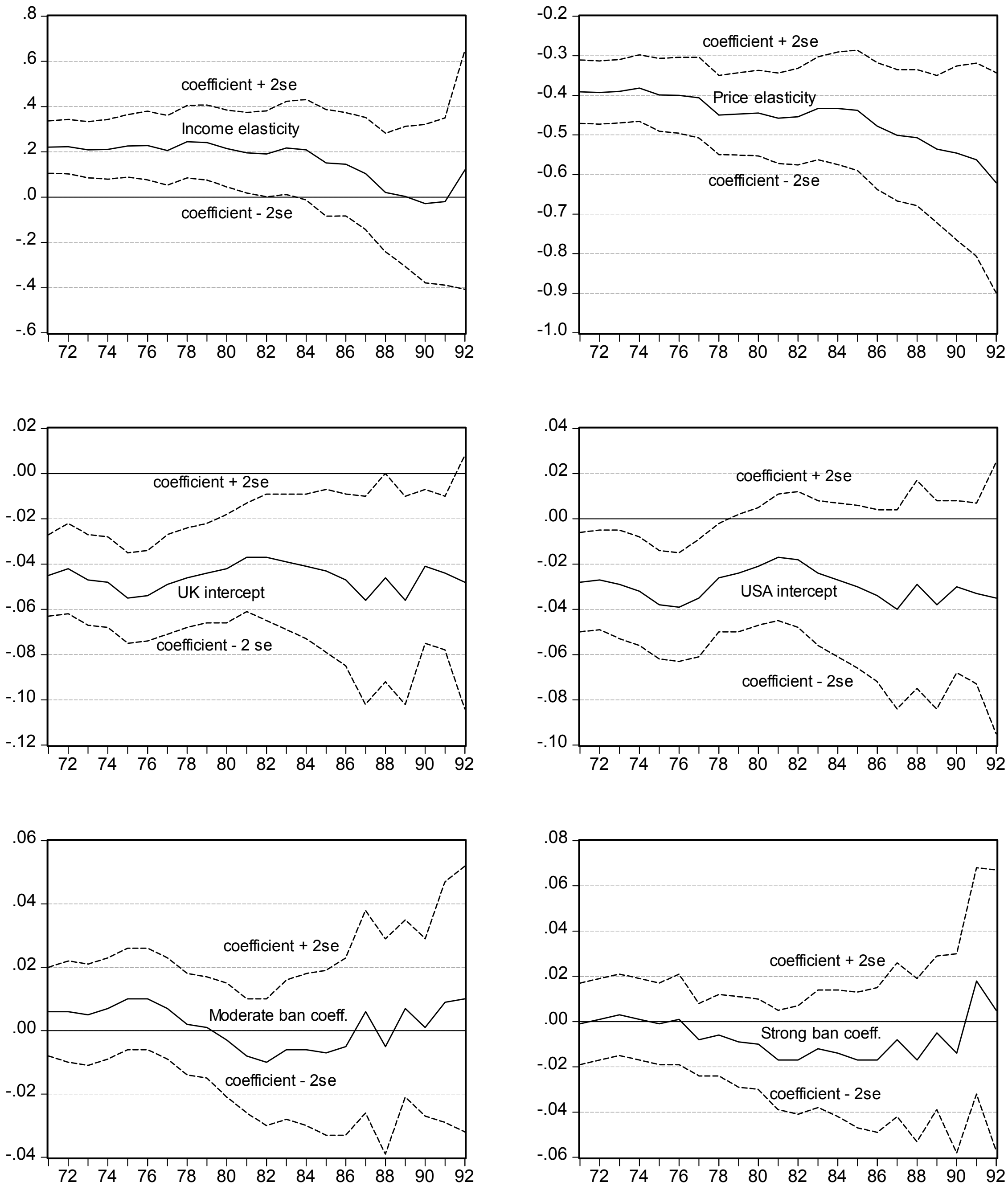
[11] As pointed by a referee, the price elasticity captures some of the effect of changing taxes *and* unmeasured anti-smoking sentiment and policies. In particular, taxes and hence prices will be higher in those countries with more anti-smoking sentiment and controls, which is reflected in the growing price elasticity. My test for endogeneity of prices (see n. 10) suggests that this problem is not severe, although clearly of interest for future investigations of these issues.

Table 4 – Growth-Rate Regressions: Cigarette and Tobacco Consumption

Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Dep. Variable (all log difference)	Total Cigs	Total Cigs	Total Cigs	Mfg. Cigs	Mfg. Cigs	Tobacco by Wt.	Tobacco by Wt.	Total Cigs Smokers
Income (log diff.)	0.220 (3.77)*	0.206 (2.66)*	0.157 (1.34)	0.275 (4.31)*	0.273 (4.29)*	0.174 (2.99)*	0.171 (2.98)*	0.092 (1.31)
Price (log diff.)	-0.389 (9.69)*	-0.403 (7.74)*	-0.436 (5.66)*	-0.418 (8.96)*	-0.415 (8.75)*	-0.264 (5.46)*	-0.258 (5.03)*	-0.366 (8.85)*
WARNING pack & ads (dummy)	0.009 (1.38)	0.011 (1.52)	0.024 (1.96)*	0.005 (0.76)	0.006 (0.77)	0.009 (1.40)	0.010 (1.43)	0.010 (1.22)
TV-RADIO (ban dummy)	---	---	---	---	-0.007 (0.81)	---	-0.013 (1.47)	---
MODERATE (ban dummy)	---	---	---	0.005 (0.59)	0.001 (0.11)	0.001 (0.11)	-0.006 (0.62)	0.004 (0.46)
STRONG (ban dummy)	---	---	---	0.010 (1.10)	0.006 (0.59)	0.001 (0.12)	-0.007 (0.69)	-0.009 (1.04)
BAN-COUNT (0 to 9 count)	-0.001 (0.33)	-0.001 (0.56)	-0.004 (1.08)	---	---	---	---	---
UK intercept	-0.043 (4.68)*	-0.044 (4.56)*	-0.039 (2.77)*	-0.044 (4.45)*	-0.038 (2.97)*	-0.041 (3.96)*	-0.030 (2.15)*	-0.024 (2.13)*
USA intercept	-0.022 (2.82)*	-0.025 (2.77)*	-0.025 (1.95)	-0.025 (2.23)*	-0.022 (1.66)	-0.034 (2.82)*	-0.027 (1.98)*	-0.010 (0.65)
R-sq (unwt)	0.473	0.450	0.475	0.442	0.443	0.298	0.303	0.335
F-stat	18.60	12.67	7.709	15.70	15.10	8.400	8.231	9.966
Heterosced. Adj	White	White	White	White	White	White	White	White
Ctry Fix Effect?	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time Period	71-95	77-95	85-95	71-95	71-95	71-95	71-95	71-95
No. of Obs	500	380	220	500	500	500	500	500

Notes: Dependent variables are log first-differences. T-statistics in parentheses are based on White's heteroscedastic-consistent estimate of the standard errors. Asterisks indicate significance at the 95% level. All regressions include 20 dummies for the OECD countries. See text and Table 2 for definitions of variables, data sources, and list of countries.

Figure 4. Recursive Coefficient Estimates by Year
(coefficient ± 2 std errors)



are rising after 1985. The time variation in the other coefficients is not as noticeable. The UK intercept is about -0.045 and significant, except during 1992-1995. The USA intercept decreases in value from about -0.02 to -0.04, but it is not significant after 1978. The advertising coefficients are never significant, although both coefficients are negative during 1980-1988. The WARNING coefficient is not shown graphically, but it is always positive at about 0.02.

Regression (6) in Table 3 was used to test formally for structural change in the demand for cigarettes. Using the data for 1971-1995, the dummy-variable version of the Chow test (Kmenta 1986, p. 421) was applied to the five non-intercept coefficients, starting with a hypothesized structural change in 1977 and progressively shortening the shift point by one year until the test indicated that a significant change had occurred. A Wald test on the joint significance of five slope dummies indicated a regime shift beginning in 1985 (p value of 0.03). Second, a Chow breakpoint test rejected homogeneity of separate regressions for 1971-1984 and 1985-1995. The test had a F-statistic of 1.37, which was significant at the 5% confidence level. Hence, interpretation of empirical results from cigarette demand studies must take into account changes in economic structure. In particular, Figure 4 shows an increase in the price elasticity and a reduction in the income elasticity for cigarettes, which is the pattern also found by Wasserman et al. (1991) using U.S. data for 1970-1988. The advertising variables are negative, but never statistically significant before or after 1985. The results in Tables 3 and 4 and the associated tests illustrate the fragility of the results reported by Saffer and Chaloupka, which are based on levels data. My results for advertising bans are not sensitive to changes in the model specification, time period, or choice of dependent variable.

5. A Public Choice Model of Advertising Bans

Results in the previous section indicate that advertising bans have had no effect on aggregate cigarette consumption, despite the spread of advertising restrictions and substantial reductions in consumption. The results suggest that tobacco-control policy follows a public choice logic; that is, advertising legislation is more likely to be supplied when smoking prevalence has fallen to a level that smokers no longer constitute an effective economic or political interest group. Other variables may offset the importance of smoking prevalence and the net outcome is the status quo or, alternatively, an increase in the number of banned media. Using this hypothesis, this section estimates a two-equation model for cigarette consumption and the adoption of stronger regulations on advertising. Advertising restrictions are scored on a nine-point scale depending on the number of media banned in each country. The public choice model represents the interests of smokers, healthcare concerns, government tax collections, and other interest groups. The economic interests of the tobacco industry are represented by smoking prevalence and country-specific dummies.

Beginning in the mid-1960s, governments have attempted to influence public perceptions of the risks associated with smoking. Government reports, public education programs, health warnings, and counter-advertising are examples of attempts to reduce smoking indirectly. Direct measures such as increased tax rates and age restrictions illustrate attempts to reduce smoking by changing its relative cost or availability. For advertising bans, the public health argument seems to rest in part on the possible role that advertising plays in reducing smoking prevalence, especially among youth. However, most countries delayed the adoption of stronger advertising bans until the 1990s when prevalence had already reached much lower levels for all age groups. For example, male prevalence dropped below 35% in the following years (1995 rates in parentheses): Australia, 1985 (28%); Austria, no (39%); Belgium, 1985 (32%); Canada, 1986 (30%); Denmark, no (36%); Finland, 1995 (35%); France, 1995 (35%); Greece, no (48%); Iceland, 1989 (32%); Ireland, 1986 (29%); Italy, 1992 (32%); Japan, no (57%); Netherlands, no (39%); New Zealand, 1984 (27%); Norway, 1994 (32%); Portugal, no (38%); Spain, no (43%); Sweden, 1976 (22%); United Kingdom, 1985 (30%); and United States, 1982 (26%).

The public choice hypothesis advanced in this study is that advertising restrictions are adopted in *response* to decreased smoking prevalence.[12] A negative sign in the adoption equation for smoking prevalence is consistent with the public choice hypothesis, while a positive sign supports the public health hypothesis. Smoking prevalence is divided according to males and females to account for possibly different effects by gender. The other explanatory variables capture the importance of additional influences on public policy regarding advertising. The demand for health cost reductions is represented by the percent of GDP accounted by healthcare costs. A positive sign is expected. The percent of tobacco expenditures accounted by taxes represents the importance of cigarette tax revenues to the government. This variable is lagged to account for its possible endogeneity, and a negative sign is expected. The percent of the population over 65 years reflects healthcare costs and related concerns with regard to the elderly. Lastly, a measure of economic "openness" is used to capture a variety of influences, such as emulation of antismoking laws due to the effects of international trade. Openness is defined as imports plus exports divided by gross domestic product. The expected signs for the last two variables are positive.

Advertising Legislation

Table 5 shows results for the structural model for three different time periods, 1971-1995, 1977-1995, and 1985-1995. Poisson regression results in (1)-(3) indicate that the adoption of stronger advertising bans is more likely as male prevalence decreases and female prevalence increases. However, the female prevalence rate is not significant after 1984, suggesting that this factor is no longer a key to explaining public policy processes. The prevalence results are inconsistent with a public interest model, which suggests that higher prevalence should lead to stronger bans. The results indicate that it was the decline in widespread smoking that lead to stronger legislation in the 1990s, rather than vice versa.

Healthcare costs and cigarette tax revenues have their expected signs. Stronger legislation is more likely to be adopted if healthcare costs represent a *larger* percent of a country's GDP and tax revenues from cigarettes are *smaller* as a percent of tobacco expenditures. However, the tax variable is insignificant during 1985-1995, suggesting that cigarette taxes are no longer being treated politically as a substitute for advertising bans. The demographic variable for the elderly is insignificant prior to 1985-1995, and significantly positive thereafter. As the percent of elderly rises, this may heighten concern with smoking by other groups because the elderly represent an increasingly larger claim on healthcare resources. The positive coefficients for openness reflect emulation of antismoking laws. Foreign economic relations might be aided by adoption of common laws on a variety of issues, including smoking. In particular, this effect appears in the form of recent attempts to harmonize tobacco advertising laws by the European Union (EU 2002). Lastly, the intercept values for the U.K. and U.S. are insignificantly different from zero, which is the case for 18 of the 20 countries (Austria and Japan are the exceptions). Overall, the empirical results for

[12] For more on the political economy of public policies toward smoking, see Bulow and Klemperer (1998), Gruber (2001), Haymond (2001), Tollison and Wagner (1992), and Viscusi (2002a, 2002b).

Table 5 – Recursive Model: Poisson and Instrumental Variable Estimates

Variable/Yrs	**(1) 1970-95**	**(2) 1977-95**	**(3) 1985-95**	**(4) 1971-95**	**(5) 1977-95**	**(6) 1985-95**
Dependent Variable	Ban-Count (Poisson)	Ban-Count (Poisson)	Ban-Count (Poisson)	Cigs per cap (log diff)	Cigs per cap (log diff)	Cigs per cap (log diff)
Income (log-diff)	---	---	---	0.2037 (3.47)*	0.1991 (2.57)*	0.1479 (1.27)
Price (log-diff)	---	---	---	-0.3830 (9.49)*	-0.4004 (7.65)*	-0.4354 (5.59)*
WARNING pack & ads (dummy)	---	---	---	0.0141 (2.14)*	0.0147 (1.82)	0.0216 (1.87)
BAN-COUNT (instrument)	---	---	---	-0.0035 (1.63)	-0.0034 (1.14)	-0.0025 (0.42)
Prevalence: Male (% smoke)	-0.0505 (5.66)*	-0.0523 (5.47)*	-0.0238 (2.71)*	---	---	---
Prevalence: Female (%smoke)	0.0542 (6.66)*	0.0337 (4.04)*	0.0038 (0.33)	---	---	---
Healthcare Cost (% GDP)	0.1129 (3.47)*	0.0638 (2.40)*	0.0615 (2.33)*	---	---	---
Lagged Tax Revenue (% exp.)	-0.0097 (2.46)*	-0.0097 (2.69)*	-0.0031 (0.94)	---	---	---
Pop > 65 yrs (% total)	0.0699 (1.82)	0.0665 (1.73)	0.0955 (2.79)*	---	---	---
Openness Index (% GDP)	0.0051 (1.59)	0.0072 (2.80)*	0.0066 (3.28)*	---	---	---
UK intercept	-0.5137 (0.64)	0.3886 (0.50)	-0.3639 (0.55)	-0.0400 (4.13)*	-0.0412 (4.08)*	-0.0406 (2.17)*
USA intercept	-0.4913 (0.76)	0.4886 (0.75)	-0.2751 (0.52)	-0.0181 (2.18)*	-0.0212 (2.14)*	-0.0277 (1.52)
Ctry Fix Effect?	Yes	Yes	Yes	Yes	Yes	Yes
Heterosced. Adj	Huber-White	Huber-White	Huber-White	White s.e.	White s.e.	White s.e.
R-Sq (unwt)	---	---	---	0.4766	0.4520	0.4729
Root MSE	1.058	0.871	0.596	---	---	---
Mean Dep Var	2.876	3.350	3.836	-0.0068	-0.0136	-0.0205

Notes: Regressions (1) - (3) are Poisson regressions with BAN-COUNT as the dependent variable. Regressions (4)- (6) are consumption growth rate regressions using total cigarettes, with fitted values of BAN-COUNT as instruments. Z-statistics and t-statistics in parentheses are based on robust standard error estimates. Asterisks indicate significance at the 95% level. See text and Table 2 for definition of variables, data sources, and list of countries.

advertising legislation illustrate the importance of political processes. The estimates for 1985-1995 are consistent with structural change due to declining prevalence and other demographic changes that affected the political environment for advertising legislation.[13]

Cigarette Demand

Fitted values from the adoption regressions are used as instruments for BAN-COUNT in the consumption growth regression. The fitted values smooth the discrete changes in the number of banned media, but none of the values are outside the range of the data.[14] For example, the fitted values for regression (1) lie between 0 and 9.5. The results for regressions (4)-(6) in Table 5 can be compared to the comparable single-equation results, which are regressions (1)-(3) in Table 4. The advertising results for 1971-1995 are stronger for the recursive model, but the advertising coefficient is not significant at conventional confidence levels. The advertising results for 1985-1995 are even weaker statistically. The income and price elasticities are about the same.

Lastly, as a further test of endogeneity, a Hausman test was performed using the residuals from the adoption equation as a variable in the consumption equation, along with the observed values of BAN-COUNT. The test failed to reject exogeneity of the advertising regressor. Hence, while the adoption equation estimates are informative with respect to the economic and political environment for legislation, the estimation of a structural model that accounts for endogeneity fails to support a relationship between advertising bans and reduced smoking. The results for the two-equation model in Table 5 are consistent with the estimates in Tables 3 and 4.

6. Conclusions

Two previous panel studies reported a significant negative effect of advertising bans on cigarette consumption, especially complete bans. The strong policy conclusions that follow from these studies cannot be confirmed based on my results. The negative effects of complete bans are not robust to (1) the use of stationary data in the form of consumption growth rates; (2) modest refinements in the model specification (e.g., including TV-radio bans and warning label dummies); and (3) different time periods. Data and estimation procedures used in previous studies are most likely picking up the significant declines in consumption that began in the late-1970s and early-1980s, which are unrelated to major changes in advertising restrictions. Beginning around 1985 the decline in smoking prevalence, along with a number of related factors, resulted in a shift in price and income elasticities. There also was a change in the political climate favoring stronger restrictions on cigarette advertising, which followed rather than caused reductions in smoking and smoking prevalence. Hence, neither the advertising-response model that motivates past studies nor the

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[13] I also experimented with including other explanatory variables in the adoption equation, including unemployment rate, percent filtered, tourism, real tax per pack, income, and a dummy shift variable for 1985-1995. None of these variables were consistently significant. I tried deleting Japan from the sample, but this did not substantially alter the results. I also applied a Hausman test for endogeneity of male and female prevalence in the adoption equation, with exogenous variables for income, unemployment rate, female labor force participation, elderly population, and percent manufactured. The test did not reject exogeneity of male or female prevalence in the adoption equation for any of the three time periods.

[14] Table 5 reports the sample mean and the standard error of estimate as an indicator of the degree of fit of the Poisson model. The model fits most countries quite well in most years. For example, 65% of the residuals in regression (1) are between +1 and −1 and 95% are between +2 and -2.

conclusions in past studies is supported by empirical results based on a broader consideration of the economic and political forces affecting the tobacco industry. These results suggest that future cross-national empirical studies would do well to focus on other tobacco control policy issues, such as the growing importance of taxes, rather than restrictions on advertising.

Colophon

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