How Effective Are Taxes in Reducing Tobacco Consumption?

Frank J. Chaloupka
Professor, Department of Economics, University of Illinois at Chicago
Research Associate, Health Economics Program, National Bureau of Economic Research
601 South Morgan Street, Room 2103
Chicago, IL 60607-7121
(312) 413-2367
(312) 996-3344
fjc@uic.edu

August 1998

Preliminary draft prepared for the International Conference on the Social Cost of Smoking, Lausanne, Switzerland, August 21-22, 1998. Comments welcome.

I. Introduction

Nearly every country in the world has taxed cigarettes, cigars, smokeless tobacco, pipe tobacco and other tobacco products for centuries. These taxes come in a variety of forms, including excise taxes, value added and sales taxes, import duties (on both unmanufactured tobacco and tobacco products), and others. In general, excise taxes are easier to collect and are changed infrequently over time, while *ad valorem* taxes change as price changes, but may impose additional administrative costs to collect. In addition to the taxes imposed by national governments, many subnational units (states, provinces, counties, cities and others) impose additional taxes. The share of taxes in the prices of tobacco products varies widely among countries. In Denmark, Ireland, and the United Kingdom, for example, over 80 percent of cigarette prices at the end of 1996 were accounted for by cigarette taxes, while cigarette taxes in most other developed countries were between 65 and 80 percent of price (Sweanor 1997). In contrast, taxes in the U.S. account for 35 percent of price on average, and taxes in many developing countries account for a relatively low share of price. The large differences in cigarette taxes lead to five-fold or more differences in cigarette prices among countries.

These taxes contribute significantly to government revenues in most countries. In many developed countries, tobacco tax revenues have constituted three to five percent of total revenues; in some developing countries, they are even more important (British American Tobacco Company Limited (BAT) 1994). However, the importance of tobacco taxes as a share of total revenues has generally declined over time in most countries. In the U.S. for example, tobacco taxes currently account for less than one-half of one percent of total federal revenues, well below their 3.36 percent of revenues in 1950.

Motives for the taxation of tobacco and tobacco products vary across countries and over time. Historically, tobacco taxes have been widely used as an easy source of revenues that minimizes the inefficiencies associated with taxation. Thus, tobacco taxes have long been thought to satisfy the Ramsey Rule that states that taxes on consumption should be applied to goods with relatively inelastic demands so that the welfare losses associated with taxation will be minimized (Warner, et al. 1995; Sunley 1998). However, new research for developing countries, as well as studies from developed countries that account for the addictive nature of cigarette smoking and other tobacco use, suggest that the demands for tobacco products, while still inelastic, may be more responsive to price than once thought.

More recently, many developed and some developing countries have increased tobacco taxes explicitly for the purpose of reducing tobacco use. These tax increases are, in part, based on economic efficiency arguments - the idea that smokers and other users of tobacco products should bear the full costs of their consumption - and assume that tobacco users impose significant social costs that are not fully reflected in the net-of-tax price of these products. Thus, the tax serves as a "users' fee" covering the costs imposed by tobacco users on non-users. This argument also reflects the "benefit principle" that states that individuals should pay for government provided services in proportion to the benefits that they derive from them, reflecting the notion that users of tobacco products use more publicly provided health care than non-users (Warner, et al. 1995).

Related to this is the use of tobacco taxes as a means for improving public health by reducing the morbidity and premature mortality associated with cigarette smoking and other tobacco use. This argument is based on the empirical evidence that higher taxes, by raising price, significantly reduce cigarette smoking and other tobacco use, particularly among youth and young adults. Given that few persons begin smoking later in life, using taxes to prevent the onset of regular tobacco use by young people can delay hundreds of thousands of deaths and add millions of years to lives that otherwise would have been shortened by smoking. The growing use globally of taxes that are earmarked for various public health activities are clear evidence of the changing motives for tobacco taxation. For example, several countries earmark cigarette and other tobacco taxes for tobacco-related education, counter-advertising, and other health-related activities (e.g. Canada, Ecuador, Finland, French Polynesia, Iceland, Nepal, Peru, Portugal, Romania, and several U.S. states), while others are considering this approach. Similarly, several Australian states and New Zealand use tobacco tax revenues to fund sporting and artistic events previously backed by the tobacco industry.

Clearly, all of these arguments depend on information concerning the impact of tobacco taxes on tobacco use. This chapter reviews the evidence on the impact of tax and price on the demands for cigarettes and other tobacco products, including their differential impact on demand in various subpopulations.

II. The Impact of Tobacco Taxes and Prices on the Demands for Tobacco Products

Perhaps the most fundamental principle of economics is the law of the downward sloping demand curve, stating that as the price of a product rises, the quantity demanded of that product falls. In the past, many researchers argued that cigarette smoking and other tobacco use, however, were exceptions to this law and that the consumption of these and other addictive products were not conducive to standard economic analysis (for example, Elster 1979; Winston 1980; Schelling 1984). However, a substantial and growing body of economic research clearly demonstrates that the demands for cigarettes and other tobacco products clearly respond to changes in prices and other economic factors, in applications of models that ignored the addictive nature of consumption as well as more recent studies that explicitly model addiction.

Conceptually, economists use a relatively broad definition of price that includes not only the monetary price of purchasing a product, but also the time and other costs associated with using that product. Restrictions on smoking in public places and private work sites, for example, impose additional costs on smokers by forcing them outdoors to smoke, raising the time and discomfort associated with smoking; or by imposing fines for smoking in restricted areas. Similarly, limits on youth access to tobacco products may raise the time and potential legal costs associated with smoking by underage youth, while new information on the health consequences of tobacco can raise the perceived long-term costs of smoking. In addition to price, a variety of other factors can affect the demands for cigarettes and other tobacco products, including income, advertising and other promotional activities, and tastes. This chapter focuses on the impact of the prices of tobacco products (which can be increased by increasing taxes) on the demands for

these products.[1] In addition to a description of the evidence from econometric studies, the findings from the small but growing body of qualitative and experimental research conducted by researchers from other disciplines will be described.

a. Conventional Studies of Cigarette Demand

Over the past several decades, numerous studies have examined the effects of taxes and prices on the demand for cigarettes using conventional models of demand that do not account for the addictive nature of smoking. These studies have used diverse econometric and other statistical methods on data from numerous countries. Most of these have focused on developed countries, including the U.S., Canada, the U.K, Ireland, Finland, Austria, other Western European countries, Australia, New Zealand and others. Many have used aggregate time-series data for a single geographical unit (i.e. country or state), while others have employed pooled cross-sectional time series data; still others have used individual-level data taken from surveys. The price elasticity estimates for overall cigarette demand from these recent studies fall within the relatively wide range from -0.14 to -1.23, but most fall in the narrower range from -0.3 to -0.5.

In recent years, a growing number of studies have focused on developing countries, including Papua New Guinea (Chapman and Richardson 1990), China (Mao 1997; Xu, Hu and Keeler 1998), Taiwan (Hsieh and Hu 1997), South Africa (van der Merwe forthcoming), and Zimbabwe (Maranvanyika forthcoming), while new research is beginning to focus on others. Warner (1990) argued that demand in less developed countries is likely to be more responsive to price in more affluent countries given the relatively low incomes and relatively low levels of cigarette consumption in poorer countries. The estimated price elasticities from the studies on developing countries are consistent with this argument, implying that cigarette demand in these countries is two or more times as sensitive to price as demand in more developed countries.

A relatively small but growing number of cigarette demand studies have used data on individuals taken from large-scale surveys. In general, the estimated price elasticities of demand from these studies are comparable to those estimated using aggregate data. Because of their use of individual-level data, these studies can examine issues that cannot be addressed using aggregate sales data. For example, most of these studies have separately estimated the effect of price on the decision to smoke and on conditional cigarette demand (cigarette consumption by smokers) (e.g. Lewit and Coate 1982; Mullahy 1985; Wasserman, et al. 1991; Chaloupka and Grossman 1996; Farrelly et al. 1998a; Evans and Farrelly forthcoming). In general, most recent studies that have used individual-level data to estimate adult cigarette demand conclude that half or more of the effect of cigarette price on overall demand is on smoking prevalence, with the remainder of the effect on cigarette consumption by continuing smokers. For example, Wasserman et al. (1991) estimated that the price elasticity of adult smoking prevalence in the U.S. in 1985 was -0.171, while the comparable conditional demand elasticity was -0.092. More recently, Farrelly and his colleagues (1998a) produced comparable estimates of -0.15 and -0.10, for prevalence and conditional demand respectively, for U.S. adults over the period from 1976 through 1993.

[1] See Chaloupka and Warner (forthcoming) for a review of the research on the impact of smoking restrictions, limits on youth access, advertising and promotion, health information, counter-advertising, and other factors on the demands for cigarettes and other tobacco products.

Evidence from the relatively new and rapidly expanding field of behavioral economics is consistent with the findings from econometric studies of the impact of price on cigarette smoking. Behavioral economics involves the application of the principles of consumer demand theory to experimental psychology (Hursh and Bauman 1987). These studies examine the impact of price and other factors on the self-administration of a number of addictive substances by humans as well as a variety of non-human species in a laboratory setting. Price, in this context, is defined as the response or effort required to receive one dose of a drug (Bickel and Madden 1998). One advantage of this experimental approach is that researchers can study the effects of price changes much larger than those observed in the cross-sectional or time-series data that have been used in the econometric studies.

The behavioral economics of cigarette smoking is the most extensively researched area in the behavioral economics of drug self-administration (Bickel and Madden 1998). Bickel and his colleagues have conducted numerous experiments to look at the impact of a wide range of price changes on cigarette consumption by adult smokers. As in the econometric studies, the behavioral economic analyses have consistently found an inverse relationship between cigarette smoking and price. Estimates of the price elasticity of demand obtained from these studies are surprisingly consistent with those obtained from econometric studies. A particularly interesting finding from the behavioral economics research is that the price elasticity of demand rises as price rises. These findings appear to be generalizable not only across drugs but also across species (Bickel et al. 1990).

b. Addiction Models and Cigarette Demand

A growing number of recent studies of cigarette demand have explicitly addressed the addictive nature of cigarette smoking. In the economic analyses of addictive behavior, the consumption of a certain good is termed to be an addiction if an increase in the past consumption of the good leads to an increase in current consumption because the marginal utility of current consumption is increased by past consumption. Empirical studies of addictive demand generally fall into two categories - those that treat smokers as behaving myopically and those that treat smokers as behaving rationally. Both types of studies attempt to account for the tolerance, reinforcement, and withdrawal associated with addictive consumption that makes current smoking decisions dependent on past cigarette consumption (U.S. Department of Health and Human Services 1988). The key implication of these models for the effect of price on the demands for an addictive substance is that, because of its addictive nature, demand will respond slowly to permanent changes in price. Thus, the long-run price elasticity of demand will exceed the short-run elasticity. The key difference in the two approaches is that myopic demand models assume smokers completely ignore the future consequences of their decisions when making current smoking choices, while rational demand models assume that smokers account, at least somewhat, for the future health and other consequences of their addiction when making current consumption decisions.

Myopic models of addiction grew out of the early economics literature on "irreversible" demand (Haavelmo 1944; Duesenberry 1949; Modigliani 1949; Farrell 1952). Farrell, for example, described an irreversible demand function as one in which current demand depends on all past price and income combinations, with the implication that price and income elasticities may differ

for increases and decreases in price and income. Farrell tested this model empirically using data on tobacco and beer consumption in the U.K. for the period from 1870 through 1938 in demand functions that included not only current prices and income, but also price, income and consumption in the previous year. While his estimates were generally inconclusive, he did find some limited evidence of habit formation.

Young (1983) and Pekurinen (1989) applied the notion of asymmetric responses to cigarette price changes using data from the U.S. and Finland, respectively. Both found that demand was almost twice as responsive to price reductions as it was to price increases (-0.61 vs. -0.33 for the U.S. and -0.94 vs. -0.49 for Finland). These findings were consistent with Young and Pekurinen's argument that addicted smokers would be less responsive to price. However, as Godfrey (1989) noted, their essentially atheoretical approach ignored the impact of past smoking on current cigarette demand and, consequently is likely to have produced biased estimates of the effects of price on demand.

Most empirical applications of myopic models of addiction are based on the early work by Houthakker and Taylor (1966, 1970) that formally introduced the dependence of current consumption on past consumption of an addictive good by modeling current demand as a function of a "stock of habits" representing the depreciated sum of all past consumption. Houthakker and Taylor estimated demand functions for a variety of goods, including cigarettes, using data for the U.S. and several Western European countries. They found considerable support for their hypothesis of habit formation in demand for almost all of the non-durable consumer goods, including cigarettes, they examined. Mullahy (1985) took a similar approach using individual-level data from the 1979 U.S. National Health Interview Survey. He also found strong evidence that cigarette smoking is an addictive behavior, and estimated an overall price elasticity of cigarette demand centered on -0.47. Other approaches to estimating myopic demand models have similarly concluded that cigarette smoking is an addictive behavior and that price has a significant impact on cigarette demand (e.g. Jones 1989; Baltagi and Levin 1986).

Several researchers have empirically modeled cigarette smoking as a rationally addictive behavior applying the theoretical model of rational addiction developed by Becker and Murphy (1988). In this model, addiction is reflected by "adjacent complementarity"; that is, the quantities of the addictive good consumed in different time periods are complements. The key implication of this is that the current consumption of an addictive good will be inversely related to not only the current price of the good, but also to all past and future prices. In addition, price responsiveness in this model varies with time preference; addicts with higher discount rates will be more responsive to changes in price than those with lower discount rates (Becker, Grossman and Murphy 1991). The opposite will be true with respect to the effects of information concerning the future consequences of addictive consumption. Thus, the model suggests that younger, less educated, and lower income persons will be relatively more responsive to changes in the money price of cigarettes, while older, more educated, and higher income persons will be relatively more responsive to new information on the health consequences of cigarette smoking. In addition, the Becker and Murphy model has several other interesting implications with respect to the effects of price on the demand for an addictive good. For example, the effect of an anticipated price change is expected to be larger than that of an unanticipated change, while the effect of a permanent price change will exceed that of a temporary change. Perhaps most

interestingly, the ratio of the long-run to short-run price elasticity will be larger as the degree of addiction rises.

Chaloupka (1988, 1990, 1991) was the first to use individual-level data to estimate cigarette demand equations derived from the Becker and Murphy rational addiction model. He found consistent evidence that smoking was an addictive behavior and that smokers did not behave myopically. Chaloupka (1991) estimated long-run price elasticities of cigarette demand in the range from -0.27 to -0.48; larger than the elasticities obtained from conventional demand equations estimated using the same data and about double the estimated short-run price elasticities. Similar findings were obtained by Becker, Grossman, and Murphy (1994) using aggregate, state-level sales data for the U.S. over the period from 1955 through 1985. They found clear evidence that smoking was addictive, as well as evidence of non-myopic, although not fully rational, behavior.[2] The authors' estimates of the short-run price elasticity of demand, ranging from -0.36 to -0.44 are generally consistent with estimates from conventional demand models. They conclude, however, that because of its addictive nature, cigarette demand is much more responsive to price in the long-run than implied by the estimates from the conventional models (their long run elasticity estimates range from -0.73 to -0.79).

Estimates from other studies employing U.S. data (Keeler et al. 1993; Sung et al. 1994) and data from other countries, including Finland (Pekurinen 1991) and Australia (Bardsley and Olekalns 1998), have produced estimates consistent with the hypothesis of rational addiction. However, estimates based on annual time-series data for the U.K. (Duffy 1996), Greece (Cameron 1997), and Ireland (Conniffe 1995) found little support for the rational addiction model. These latter studies, however, are generally limited by the relatively small number of observations available for their analyses and the use of several highly correlated regressors.

Finally, Douglas (1998) used hazard models to examine the determinants of smoking initiation and cessation in the context of the Becker and Murphy (1988) rational addiction model. In contrast to his finding that price does not significantly affect the hazard of smoking initiation (discussed below), Douglas concluded that increases in price significantly raise the hazard of smoking cessation. He estimated that the duration of the smoking habit is approximately unitary elastic with respect to cigarette price.

Recent theoretical extensions to the rational addiction model have attempted to address its often criticized assumption of perfect foresight and consequent lack of regret. Orphanides and Zervos (1995), for example, introduced these elements into the Becker and Murphy rational addiction model by assuming that inexperienced users are not fully aware of the potential harm associated with consuming an addictive substance. Instead, their knowledge comes from observing the effects of addictive consumption on others as well as through their own experimentation. In their model, an individual who underestimates his or her potential for addiction and experiments with addictive consumption can end up hooked to his/her regret. Similarly, Suranovic, Goldfarb and

[2] Estimates from unrestricted models containing past and future cigarette prices as instruments for past and future cigarette consumption produced relatively high estimates of the discount rate, implying less than fully rational behavior. Estimates from a variety of other specifications were also presented, including those for models that imposed a more reasonable discount rate. The authors concluded that there was insufficient information in the data to accurately estimate the discount rate, but that their estimates were clearly inconsistent with myopic behavior.

Leonard (forthcoming) emphasize the "quitting costs" implied by the adjacent complementarity of addictive consumption in order to explain the seeming inconsistency between smokers' stated wishes to quit smoking and their continued cigarette consumption, as well as their use of alternative behavior modification treatments, such as the nicotine patch. Likewise, rather than assuming fully rational behavior as in the Becker and Murphy model, Suranovic and his colleagues assume "boundedly rational" behavior implying that individuals choose current consumption only rather than choosing a lifetime consumption path that maximizes the present value of their lifetime utility. Empirical applications of these extensions are likely to add significantly to our understanding of the impact of price and other factors on cigarette smoking.

c. Subgroup Differences in the Price Elasticity of Cigarette Demand

A number of recent studies based of cigarette demand based on individual-level data have taken advantage of these data to explore differences in the price sensitivity of different population subgroups. The most studied subgroups have been those defined by age, with a particular focus on youth and young adults given that most smoking initiation takes place during the teenage years and becomes firmly established during young adulthood. Lewit and his colleagues were the first to examine differences in price sensitivity by age, using data from several large U.S. surveys (Lewit, Coate, and Grossman 1981; Lewit and Coate 1982; Grossman, et al. 1983). They estimated an overall price elasticity of cigarette demand for adults of -0.42, with a prevalence elasticity of -0.26 (Lewit and Coate 1982). However, they found that demand among young adults, ages 20 through 25 years, was more than twice as responsive to price, with an overall elasticity of -0.89, and that most of the effect of price on young adult smoking was on the decision to smoke (with an estimated prevalence elasticity of -0.74). Similarly, Lewit, Coate and Grossman (1981) found that youth, ages 12 through 17 years, were even more responsive to price, with an estimated overall price elasticity of demand of -1.44; again, Lewit and his colleagues concluded that most of the effect of price on youth smoking was on the decision to smoke (an estimated prevalence elasticity of -1.20).

Lewit, Coate, and Grossman (1981) suggested two reasons for the greater price sensitivity of youth. First, given the addictive nature of smoking, they argued that long-term adult smokers would likely adjust less quickly to changes in price than youth who have been smoking for a relatively short time. In addition, they noted that youth smoking is more influenced by peer behavior than is adult smoking, multiplying the effects of price on youth smoking. That is, an increase in cigarette price directly reduces a given youth's smoking and then indirectly reduces it by lowering peer smoking. Grossman and Chaloupka (1997) offered two additional reasons. First, the fraction of disposable income a young smoker spends on cigarettes is likely to exceed that spent by an adult smoker. Second, compared to adults, youth are likely to be more present-oriented. As discussed above, in the context of the rational addiction model, this implies that a change in money price will have a greater impact on youth smoking than it will for adults.

A decade later, two studies, both based on relatively small samples from the same U.S. survey, concluded that youth and young adults were not significantly more sensitive to price than older adults (Wasserman et al. 1991; Chaloupka 1991). However, a number of recent U.S. studies based on several large, nationally representative surveys, have supported Lewit and his colleagues' findings of an inverse relationship between price elasticity and age (Chaloupka and

Grossman 1996; Chaloupka and Wechsler 1997; Lewit, et al. 1997; Evans and Huang 1998; Tauras and Chaloupka 1998; Farrelly, et al. 1998a). Chaloupka and Grossman (1996), for example, used data on over 110,000 eighth, tenth, and twelfth grade students to estimate the impact of price and a variety of tobacco control policies on youth cigarette smoking. They estimated a total price elasticity of -1.31, strikingly similar to that estimated by Lewit and his colleagues. In contrast, Chaloupka and Grossman found that the effects of price on youth smoking prevalence and conditional demand were similar (elasticities of -0.68 for prevalence and -0.64 for conditional demand). Similarly, using 13 of the U.S. National Health Interview Surveys conducted from 1976 through 1993, Farrelly and his colleagues estimated a total price elasticity of demand of -0.58 for young adults (ages 18 through 24 years), almost 40 percent higher than the -0.42 they estimated for 25 through 39 year olds and well above the -0.10 they estimated for older adults.

In general, researchers examining the effects of price on smoking participation using individual-level data from cross-sectional surveys have assumed that much of the impact of price on smoking prevalence reflects the impact of price on smoking initiation by youth and smoking cessation by adults. A few recent studies have attempted to directly examine the effect of price on smoking initiation. Douglas (1998) and Douglas and Hariharan (1994) used retrospective data from smoking supplements to several of the U.S. National Health Interview Surveys, matching prices from each respondents' current state of residence at the time they reported beginning smoking, to examine the impact of price on initiation. Using hazard methods in the context of the Becker and Murphy model of rational addiction, they concluded that cigarette prices had little impact on smoking initiation. However, as the authors note, the errors-in-variables problems associated with both the retrospective data on smoking initiation and the cigarette price data biased their price effects towards zero.

DeCicca, Kenkel and Mathios (1998) addressed the same issue using data on youth taken from the 1988 U.S. National Education Longitudinal Survey. These data are not subject to the same errors-in-variables problems as the data based on respondents' recall of age at smoking initiation. DeCicca and his colleagues, however, also found little impact of cigarette taxes or prices on the onset of daily smoking between the eighth and twelfth grade waves of their data. However, a recent re-analysis of these data by Dee and Evans (1998) concluded that this finding was largely the result of the way in which DeCicca and his colleagues constructed their sample. Rather than dropping a significant portion of their sample with missing data on income and other key independent variables, Dee and Evans included these observations along with dummy variables indicating observations for which the data were missing. In addition, they included a variety of binary indicators for categorically collected data rather than constructing "continuous" measures from these data as did DeCicca, et al. After making these changes, but otherwise using the same basic approach, Dee and Evans concluded that higher cigarette taxes significantly reduced the onset of daily smoking. Their estimated price elasticity of smoking onset of -0.63 is very consistent with the estimated prevalence elasticities from several other recent studies of youth smoking based on cross-sectional data.

Finally, qualitative data collected in focus groups of young smokers conducted recently by the U.S. Centers for Disease Control sponsored network of prevention research centers support the findings from the econometric research. In a number of focus groups of youths from 13 sites

across the U.S., high school age smokers were asked to react to alternative approaches to tobacco control, including significant price increases, stronger health warning labels, ingredients disclosure, stronger limits on youth access to tobacco, stronger penalties for youth possession of tobacco products, and more. While a few of the proposed policies got the attention of some of the teens, the only policy that all consistently indicated would get them to quit smoking or cut back on their cigarette consumption was a significant increase in the price of cigarettes (Balch, personal communication).

Two recent studies have used U.S. survey data to examine differences in price sensitivity by race and ethnicity. Farrelly and his colleagues (1998a) concluded that smoking by Hispanic adults is very sensitive to price, with an estimated overall price elasticity of demand of -1.89. In contrast, cigarette demand among Black, non-Hispanics and White, non-Hispanics was found to be relatively inelastic. Interestingly, the effect of price on smoking by Black, non-Hispanics appears to be limited to its impact on smoking prevalence (an estimated prevalence elasticity of -0.36 compared to an estimated conditional demand elasticity of 0.04), and is well above the effect of price on White, non-Hispanic smoking (estimated elasticities of -0.05 and -0.09 for prevalence and conditional demand, respectively). Chaloupka and Pacula (1998) found similar differences among Black and White youths.

To the extent that socioeconomic status is correlated with race and ethnicity, these findings may, in part, reflect differences in price sensitivity related to differences in socioeconomic status. Three recent studies have explored differences in price sensitivity based on income and educational attainment. Townsend, and her colleagues (1994) used data from the British General Household Survey and concluded that people in the lowest income groups were most responsive to price increases. Farrelly and his colleagues (1998a) found the same is true in the U.S. They estimated that the price elasticity of cigarette demand by persons at or below the median family income level in their sample was over 70 percent larger than their estimate for persons above the median. Chaloupka's (1991) finding, in the context of the rational addiction model, that less educated persons were relatively sensitive to price while more educated persons were generally insensitive to price is consistent with the conclusions reached by Townsend, et al. (1994), and Farrelly, et al. (1998a).

These findings have important implications with respect to the perceived regressivity of tobacco tax increases. There is substantial evidence, at least from developed countries, that tobacco consumption has become increasingly concentrated in lower income groups and that tobacco taxes paid as a share of income fall as income rises. Given this, many have argued that increases in tobacco taxes are highly regressive. However, the findings that lower income persons are more responsive to cigarette price changes than higher income persons suggests that the regressivity of tobacco tax increases has been overstated. Using the estimates described above, Farrelly concludes that the relative share of federal taxes paid by low income smokers in the U.S. would decline as price increases, while that paid by high income smokers would increase, reducing the apparent regressivity of tobacco taxes (Farrelly, personal communication).

Finally, several studies have examined differences in price sensitivity between men and women. In general, studies from the U.S. have consistently found that men are relatively more price sensitive than women (Lewit and Coate 1982; Mullahy 1985; Chaloupka 1990; Farrelly, et al.

1998a; Chaloupka and Pacula 1998). In contrast, Townsend and her colleagues (1994) found that cigarette demand by women in the U.K. was more price responsive than demand by men.

d. Price, Tax, Substitution, and Compensating Behavior

In contrast to the relatively large literature examining the impact of cigarette taxes and prices on smoking, relatively few studies have examined the demands for other tobacco products, and fewer still have estimated cross-price effects for cigarettes and other tobacco products. Much of the research on adults in the U.S. has been conducted by Ohsfeldt and his colleagues using data from the tobacco use supplements to various waves of the Current Population Survey (Ohsfeldt and Boyle 1994; Ohsfeldt, Boyle and Capilouto 1997; Ohsfeldt, Boyle and Capilouto 1998). The authors consistently find that higher taxes on smokeless tobacco products would significantly reduce the prevalence of smokeless tobacco use among adult males. Chaloupka, Tauras and Grossman (1997) found similar evidence with respect to both the probability and frequency of smokeless tobacco use among young males. In addition, Ohsfeldt and his colleagues found evidence of substitution among tobacco products, in that higher cigarette taxes were estimated to significantly increase the probability of smokeless tobacco use.

Thompson and McLeod (1976) and Pekurinen (1989, 1991) found similar evidence of substitution, concluding that Candadian and Finnish smokers, respectively, would switch from manufactured cigarettes to less expensive hand-rolled cigarettes in response to an increase in the relative price of manufactured cigarettes. In contrast, Leu (1984) found little evidence of substitution among tobacco products by Swiss tobacco users in response to changes in relative prices. Finally, Pekurinen also found a negative and significant relationship between the demands for pipe tobacco and cigars and their own prices.

In a very interesting recent study, Evans and Farrelly (forthcoming) considered a different type of substitution in response to increased cigarette taxes. They used data from the 1979 and 1987 supplements to the U.S. National Health Interview Survey to examine compensating behavior by smokers in response to cigarette tax and price changes. The supplements contained unique data on the type of cigarettes consumed by smokers that Evans and Farrelly combined with data from the U.S. Federal Trade Commission on the tar and nicotine content of cigarette brands to construct alternative measures of daily smoking intensity. These measures included total cigarette consumption, total length of cigarettes consumed, tar intake, and nicotine intake. While finding consistent evidence that the prevalence of smoking and average daily cigarette consumption fell in response to higher cigarette taxes, Evans and Farrelly found that continuing smokers engaged in a variety of compensating behaviors. Specifically, smokers in high-tax states consumed longer cigarettes and cigarettes with higher tar and nicotine contents than those consumed by smokers in lower-tax states. Moreover, they found that the younger smokers were more likely to engage in this type of compensating behavior. As a result, they argued that the perceived health benefits associated with higher cigarette taxes, while substantial, may be overstated given the compensating behavior of smokers. Consequently, Evans and Farrelly suggested that cigarette taxes based on tar and nicotine content may be needed to ensure the maximum health benefits from tax increases, a proposal first made by Harris (1980). In practice, however, tar and nicotine based taxes have been infrequently used (they were used briefly in the

U.K., for example), in part because of the administrative difficulties associated with this type of tax.

While this compensating behavior may partially offset the health benefits of higher tobacco taxes, two recent studies that directly examined the impact of cigarette taxes on health-related outcomes clearly show that the health benefits of higher taxes are substantial. Moore's (1996) econometric analysis of annual state-level data from the U.S. on tobacco-related death rates for the period from 1954 through 1988 concluded that higher cigarette taxes would significantly reduce smoking-related deaths. His estimates imply that a 10 percent increase in the cigarette tax would lead to approximately 6,000 fewer premature, smoking-related deaths in the U.S. per year. Similarly, Evans and Ringel (forthcoming) examined whether or not higher state cigarette taxes can be used to improve birth outcomes. Using data on approximately 10.5 million births in the U.S. over the period from 1989 through 1992, the authors estimated a smoking prevalence elasticity of -0.5 for pregnant women and found that increased cigarette taxes would significantly raise birth weight.

Finally, in the recent debate over large cigarette tax increases in the U.S., some have suggested that the consequent cigarette price increases would lead youths to substitute marijuana for cigarettes. However, the limited empirical evidence on this issue suggests that higher cigarette taxes and prices would not only reduce cigarette smoking, but also lead to reductions in marijuana and other substance use. Research on patterns of substance use among youth generally concludes that youth begin with tobacco and/or alcohol and that some youth progress to marijuana and other illicit drug use, with few drug users avoiding cigarettes and/or alcohol (Kandel 1975; Kandel and Yamaguchi 1993; U.S. Department of Health and Human Services 1994). Similarly, other research concludes that cigarette smoking is a significant predictor of both the probability and frequency of other drug use (U.S. Department of Health and Human Services 1988; Henningfield, Clayton and Pollin 1990).

These conclusions are supported by the limited econometric evidence that finds that cigarettes and marijuana appear to be complements for both youth and adults. Using data for adults taken from several of the U.S. National Household Surveys on Drug Abuse, Farrelly and his colleagues (1998b) found that higher cigarette prices reduced the probability and frequency of alcohol and marijuana use. Chaloupka and his colleagues (1998) reached a similar conclusion for youth marijuana use using data from the Monitoring the Future surveys of eighth, tenth, and twelfth grade students.

III. Discussion

The review of the literature thus far clearly indicates that higher taxes on tobacco products will lead to significant reductions in cigarette smoking and other tobacco use. Several caveats, however, should be noted.

First, for tobacco tax increases to have their maximum impact on consumption, the real value of the tax increase must be maintained over time. While *ad valorem* taxes will increase with the nominal prices of tobacco taxes, excise taxes will not. Instead, tobacco excise taxes will be eroded by inflation unless they are increased frequently and by sufficient amounts to maintain

their real value. When this does not happen, the real values of the taxes declines over time and, given the importance of taxes in prices, so does the relative price of tobacco products, leading to increases in cigarette smoking and other tobacco use. In the U.S. for example, the stability of state and federal cigarette taxes during the 1970s was the major factor behind the nearly 40 percent decline in real cigarette prices from 1971 through 1981.

Second, given the evidence described above concerning the potential for substitution among tobacco products, comparable increases in the taxes on all tobacco products are needed to maximize the health benefits of a tobacco tax hike. Increasing the relative tax on cigarettes, for example, while holding the taxes on other tobacco products constant will lead to significant reductions in cigarette smoking, but is likely to lead some smokers to switch from manufactured cigarettes to other tobacco products. Moreover, given the recent study by Evans and Farrelly (forthcoming) on the compensating behavior of smokers, differential cigarette taxes based on tar and nicotine content may be needed to maximize the health benefits of a cigarette tax increase. More research is clearly needed, however, to determine the impact of this type of tax structure.

Third, the impact of a tobacco tax increase on consumption depends on the magnitude of the price increase that results from the tax hike. Several studies have considered the relationship between cigarette taxes and cigarette prices in the U.S. The earliest studies produced generally inconsistent conclusions concerning how much cigarette prices would rise after an increase in cigarette taxes (e.g. Barzel 1976; Sumner 1981; Bishop and Yoo 1985). One problem with these studies was that they typically failed to account for the dynamic interaction between firms in the highly concentrated cigarette industry, assuming instead that the rules for firm behavior were established and then working backward to determine the degree of competition in the industry (Harris 1987).

Several recent studies have addressed these weaknesses. Harris (1987), for example, used data on production costs and wholesale and retail cigarette prices in the early 1980s to examine the impact on price of the doubling of the U.S. federal cigarette excise tax in 1983. He concluded that the eight cent tax increase led to a 17 cent price increase that could not be accounted for by increases in production costs. Instead, Harris suggested that the oligopolistic firms used the tax increase as a coordinating mechanism for a joint oligopolistic price increase. More recent research by Keeler, Hu and their colleagues, however, did not find similar evidence of a disproportionately large price increase resulting from a tax increase (Sung et al., 1994; Barnett, et al. 1995; Keeler, et al. 1996). In general, they concluded that a one-cent increase in the U.S. federal cigarette tax would produce about a one-cent increase in cigarette prices, while a comparable increase in a state's cigarette tax would lead to a somewhat smaller increase in price given the possible cross-border shopping that may result.

Fourth, to the extent that organized and casual smuggling of tobacco products results from a tobacco tax increase, the effects of the increase on consumption may be somewhat reduced. In recent years, opponents of tobacco tax hikes have successfully argued that the magnitude of cigarette smuggling resulting from tax differentials with nearby countries was large enough to persuade the Canadian and, more recently, Swedish governments to reduce their relatively high taxes on cigarettes. While it is true that cigarette smuggling in both countries was significant, individual-level survey data from both suggest that the tax increases in these countries had

produced significant reductions in smoking prevalence (Sweanor and Martial 1994; Nordgren 1998). Moreover, smoking prevalence in Canada, particularly among youth, has increased significantly since the 1994 reductions in Canadian taxes, while cigarette tax revenues have declined (Kaiserman, personal communication).

Moreover, while differences in cigarette and other tobacco taxes among countries (or jurisdictions within countries) do result in some organized and casual "butt"legging, the price differences are not the only, or necessarily the most important determinant of cigarette smuggling (Joossens and Raw 1995, 1998; Joossens and van der Merwe 1997). Joossens and his colleagues suggest that the presence of informal distribution networks, nonexistent or weak policies concerning cigarette smuggling, and their lack of enforcement can be as or more important determinants of smuggling than price differentials. They note, for example, that there is little evidence of smuggling in some high-priced European countries (including France and the U.K.) while there is extensive evidence of smuggling in those with relatively low prices (including Spain and Italy). Moreover, Joossens and Raw (1998) conclude that much of the smuggling that does occur in Europe and elsewhere is encouraged by multinational tobacco companies, an argument supported by Thursby and Thursby's (1994) empirical analysis of interstate cigarette smuggling in the U.S. Finally, as Joossens and van der Merwe (1997) describe, several relatively easy options exist for limiting cigarette smuggling. These include prominent tax-paid markings on all tobacco products and sizable increases in the penalties for cigarette smuggling. The Advisory Commission on Intergovernmental Relations (1985), for example, concluded that increases in the penalties for interstate cigarette smuggling in the U.S. led to substantial reductions in this activity.

Finally, earmarking cigarette and other tobacco taxes for other tobacco control efforts, including tobacco-related education and prevention efforts, anti-smoking media campaigns, improved access to cessation programs, and other public health efforts enhances the impact of a tobacco tax increase. Indeed, earmarking funds from tobacco tax increases for tobacco control efforts as well as for crop diversification and other approaches aimed at reducing the impact on tobacco growers can help reduce some of the perceived inefficiencies associated with the tax hikes, reducing any welfare losses associated with the tax increase (Hu, Xu and Keeler forthcoming). A growing literature clearly demonstrates that the impact of tobacco tax funded anti-smoking efforts in California, Massachusetts, and elsewhere have led to reductions in tobacco use in excess of those that would have been achieved in the absence of earmarking (Hu, et al. 1994; Hu, Sung and Keeler 1995a, 1995b; Harris, Connolly and Davis 1996; Chaloupka and Grossman 1996).

IV. Conclusions

The review of the economics and other literature on the impact of tobacco tax and price increases on tobacco consumption presented above clearly shows that the answer to the question posed in the title of this chapter - "how effective are taxes in reducing tobacco consumption?" - is "very effective." Increasing taxes on cigarettes and other tobacco products will lead to significant reductions in the use of these products. These reductions will result from both reductions in the frequency of use by continuing users, as well as substantial reductions in the prevalence of use. The decline in prevalence is the result of both reduced initiation among youth and increased

cessation among adults. Moreover, the largest reductions will occur in groups that have proven more difficult to reach with other tobacco control efforts - youth and young adults, racial and ethnic minorities, and less educated and lower income populations. Given this evidence, significantly increasing the prices of cigarettes and other tobacco products by sharply increasing the taxes on these products, which would significantly reduce their use, is the single most effective policy option for reducing the public health toll from tobacco. When combined with other tobacco control activities, including prevention and cessation programs, counter-advertising, comprehensive and aggressive enforcement of limits on youth access, and more, which could be funded by earmarked tobacco taxes, even larger reductions in youth and adult tobacco use could be achieved.

V. Literature Cited

Advisory Commission on Intergovernmental Relations. *Cigarette Tax Evasion: A Second Look.* Washington: Advisory Commission on Intergovernmental Relations, 1985.

Baltagi BH, Levin D. Estimating dynamic demand for cigarettes using panel data: the effects of bootlegging, taxation, and advertising reconsidered. *Review of Economics and Statistics* 1986;68(1):148-55.

Bardsley P, Olekalns N. *Cigarette and Tobacco Consumption: Have Anti-smoking Policies Made a Difference?* Working Paper. Department of Economics, The University of Melbourne, 1998.

Barnett PG, Keeler TE, Hu T-W. Oligopoly structure and the incidence of cigarette excise taxes. *Journal of Public Economics* 1995;57(3):457-70.

Barzel Y. An alternative approach to the analysis of taxation. *Journal of Political Economy* 1976;84(6):1177-97.

Becker GS, Grossman M, Murphy KM. Rational addiction and the effect of price on consumption. *American Economic Review* 1991;81:237-41.

Becker GS, Grossman M, Murphy KM. An empirical analysis of cigarette addiction. *American Economic Review* 1994;84(3):396-418.

Becker GS, Murphy KM. A theory of rational addiction. *Journal of Political Economy* 1988;96(4):675-700.

Bickel WK, DeGrandpre RJ, Higgins ST, Hughes JR. Behavioral economics of drug self-administration. I. Functional equivalence of response requirement and drug dose. *Life Science* 1990;47:1501-10.

Bickel WK, Madden GJ. *The Behavioral Economics of Smoking*. National Bureau of Economic Research Working Paper Number 6444, 1998.

Bishop JA, Yoo JH. "Health scare," excise taxes and advertising ban in the cigarette demand and supply. *Southern Economic Journal* 1985;52(2):402-11.

British American Tobacco Company Limited. *Tobacco Taxation Guide: A Guide to Alternative Methods of Taxing Cigarettes and Other Tobacco Products*. Woking (England): Optichrome The Printing Group, 1994.

Cameron S. Are Greek smokers rational addicts? *Applied Economics Letters* 1997;4(7):401-2.

Chaloupka FJ. An economic analysis of addictive behavior: the case of cigarette smoking [dissertation]. New York: City University of New York Graduate School, 1988.

Chaloupka FJ. *Men, Women, and Addiction: The Case of Cigarette Smoking*. National Bureau of Economic Research Working Paper Number 3267, 1990.

Chaloupka FJ. Rational addictive behavior and cigarette smoking. *Journal of Political Economy* 1991;99(4):722-42.

Chaloupka FJ, Grossman M. *Price, Tobacco Control Policies and Youth Smoking.* National Bureau of Economic Research Working Paper No. 5740, 1996.

Chaloupka FJ, Pacula RL. *An Examination of Gender and Race Differences in Youth Smoking Responsiveness to Price and Tobacco Control Policies.* National Bureau of Economic Research Working Paper No. 6541, 1998.

Chaloupka FJ, Pacula RL, Farrelly MC, Johnston LD, O'Malley PM. Do higher cigarette prices encourage youth to use marijuana? Working paper, Department of Economics, University of Illinois at Chicago, 1998.

Chaloupka FJ, Tauras JA, Grossman M. Public policy and youth smokeless tobacco use. *Southern Economic Journal* 1997;64(2):503-16.

Chaloupka FJ, Warner KE. The economics of smoking. In: Newhouse JP, Cuyler A, editors. *The Handbook of Health Economics.* New York: North Holland, forthcoming.

Chaloupka FJ, Wechsler H. Price, tobacco control policies and smoking among young adults. *Journal of Health Economics* 1997;16(3):359-73.

Chapman S, Richardson J. Tobacco excise and declining tobacco consumption: The case of Papua New Guinea. *American Journal of Public Health* 1990;80(5):537-40.

Conniffe D. Models of Irish tobacco consumption. *Economic and Social Review* 1995;26(4):331-47.

DeCicca P, Kenkel D, Mathios A. Putting out the fires: will higher cigarette taxes reduce youth smoking? Presented at the Annual Meetings of the American Economic Association, Chicago, IL, January 1998.

Dee TS, Evans WN. *A Comment on DeCicca, Kenkel, and Mathios.* Working Paper. School of Economics, Georgia Institute of Technology, 1998.

Douglas S. The duration of the smoking habit. *Economic Inquiry* 1998;36(1):49-64.

Douglas S, Hariharan G. The hazard of starting smoking: estimates from a split population duration model. *Journal of Health Economics* 1994;13(2):213-30.

Duesenberry JS. *Income, Saving, and the Theory of Consumer Behavior.* Cambridge (MA): Harvard University Press, 1949.

Duffy M. Econometric studies of advertising, advertising restrictions, and cigarette demand: a survey. *International Journal of Advertising* 1996;15:1-23.

Elster J. *Ulysses and the Sirens: Studies in Rationality and Irrationality.* Cambridge: Cambridge University Press, 1979.

Evans WN, Farrelly MC. The compensating behavior of smokers: taxes, tar and nicotine. *RAND Journal of Economics*, forthcoming.

Evans WN, Huang LX. Cigarette taxes and teen smoking: new evidence from panels of repeated cross-sections. Working paper, Department of Economics, University of Maryland, 1998.

Evans WN, Ringel JS. Can higher cigarette taxes improve birth outcomes? *Journal of Public Economics*, forthcoming.

Farrell MJ. Irreversible demand functions. *Econometrica* 1952;20:171-86.

Farrelly MC, Bray JW, Office on Smoking and Health. Response to increases in cigarette prices by race/ethnicity, income, and age groups - United States, 1976-1993. *Morbidity and Mortality Weekly Report* 1998;47(29):605-9.

Farrelly MC, Bray JW, Zarkin GA. Own- and cross-price and policy effects for alcohol, tobacco, and marijuana: Evidence from the National Household Surveys on Drug Abuse. Presented at the 74th Annual Conference of the Western Economic Association, Lake Tahoe, NV, July 1998.

Godfrey C. Factors influencing the consumption of alcohol and tobacco: the use and abuse of economic models. *British Journal of Addiction* 1989;84:1123-38.

Grossman M, Chaloupka FJ. Cigarette taxes: The straw to break the camel's back. *Public Health Reports* 1997;112(4):290-7.

Grossman M, Coate D, Lewit EM, Shakotko RA. *Economic and Other Factors in Youth Smoking.* Washington: National Science Foundation, 1983.

Haavelmo T. The probability approach in econometrics. *Econometrica* 1944;12:96-124.

Harris JE. Taxing tar and nicotine. *American Economic Review* 1980;70(3):300-11.

Harris JE. The 1983 increase in the federal cigarette excise tax. In: Summers LH, editor. *Tax Policy and the Economy.* Vol. 1. Cambridge (MA): MIT Press, 1987.

Harris JE, Connolly GN, Davis B. Cigarette smoking before and after an excise tax increase and an antismoking campaign - Massachusetts, 1990-1996. *Morbidity and Mortality Weekly Report* 1996;45(44):966-9.

Henningfield JE, Clayton R, Pollin W. Involvement of tobacco in alcoholism and illicit drug use. *British Journal of Addiction* 1990;85(2):279-92.

Houthakker HS, Taylor LD. *Consumer Demand in the United States, 1929-1970: Analyses and Projections.* Cambridge (MA): Harvard University Press, 1966.

Houthakker, HS, Taylor LD. *Consumer Demand in the United States, 1929-1970: Analyses and Projections.* 2nd ed. Cambridge (MA): Harvard University Press, 1970.

Hsieh C-R, Hu T-W. *The Demand for Cigarettes in Taiwan: Domestic versus Imported Cigarettes.* Discussion Paper No. 9701. Nankang, Taipei: The Institute of Economics, Academia Sinica, 1997.

Hu T-W, Bai J, Keeler TE, Barnett PG, Sung H-Y. The impact of California Proposition 99, a major anti-cigarette law, on cigarette consumption. *Journal of Public Health Policy* 1994;15(1):26-36.

Hu T-W, Sung H-Y, Keeler TE. Reducing cigarette consumption in California: tobacco taxes vs an anti-smoking media campaign. *American Journal of Public Health* 1995a;85(9):1218-22.

Hu T-W, Sung H-Y, Keeler TE. The state antismoking campaign and the industry response: the effects of advertising on cigarette consumption in California. *American Economic Review* 1995b;85(2):85-90.

Hu T-W, Xu X, Keeler TE. Earmarked tobacco taxes: Lessons learned. In: Abedian I, van der Merwe R, Wilkins N, Jha P, eds. *The Economics of Tobacco Control: Towards an Optimal Policy Mix.* Cape Town: University of Cape Town and the World Bank, forthcoming.

Hursh SR, Bauman RA. The behavioral analysis of demand. In: Green L, Kagel JH, editors. *Advances in Behavioral Economics. Volume 1.* Norwood (NJ): Ablex Publishing Corporation, 1987:117-65.

Jones AM. A systems approach to the demand for alcohol and tobacco. *Bulletin of Economic Research* 1989;41:85-105.

Joossens L, Raw M. Smuggling and cross border shopping of tobacco in Europe. *British Medical Journal* 1995;310:1393-7.

Joossens L, Raw M. Cigarette smuggling in Europe: Who really benefits? *Tobacco Control* 1998;7(1):66-71.

Joossens L, van der Merwe R. Cigarette trade and smuggling. Project Update #7, The Economics of Tobacco Control Project, Cape Town, South Africa, 1997.

Kandel DB. Stages in adolescent involvement in drug use. *Science* 1975;190(4217):912-4.

Kandel DB, Yamaguchi R. From beer to crack: Developmental patterns of drug involvement. *American Journal of Public Health* 1993;83(6):851-5.

Keeler TE, Hu T-W, Barnett PG, Manning WG. Taxation, regulation and addiction: a demand function for cigarettes based on time-series evidence. *Journal of Health Economics* 1993;12(1):1-18.

Keeler TE, Hu TW, Barnett PG, Manning WG, Sung HY. Do cigarette producers price-discriminate by state? An empirical analysis of local cigarette pricing and taxation. *Journal of Health Economics* 1996;15:499-512.

Leu RE. Anti-smoking publicity, taxation, and the demand for cigarettes. *Journal of Health Economics* 1984;3(2):101-16.

Lewit EM, Coate D. The potential for using excise taxes to reduce smoking. *Journal of Health Economics* 1982;1(2):121-45.

Lewit EM, Coate D, Grossman M. The effects of government regulation on teenage smoking. *Journal of Law and Economics* 1981;24(3):545-69.

Lewit EM, Hyland A, Kerrebrock N, Cummings KM. Price, public policy and smoking in young people. *Tobacco Control* 1997;6(S2):17-24.

Mao ZZ. Demand for cigarettes and price policy: A time-series analysis (in Chinese). Working paper, School of Public Health, West China University of Medical Sciences, Sichuan, China, 1996.

Maranvanyika E. The search for an optimal tobacco control policy in Zimbabwe. In: Abedian I, van der Merwe R, Wilkins N, Jha P, eds. *The Economics of Tobacco Control: Towards an Optimal Policy Mix.* Cape Town: University of Cape Town and the World Bank, forthcoming.

Modigliani F. Fluctuations in the savings-income ratio: a problem in economic forecasting. In: *Studies in Income and Wealth*. New York: National Bureau of Economic Research, 1949..

Moore MJ. Death and tobacco taxes. *RAND Journal of Economics* 1996;27(2):415-28.

Mullahy J. Cigarette smoking: habits, health concerns, and heterogeneous unobservables in a micro-econometric analysis of consumer demand [dissertation]. Charlottesville (VA): University of Virginia, 1985.

Nordgren P, Sweden - Only one if five smokes daily, *GLOBALink Tobacco: Weekly European News Bulletin*, July 20, 1998.

Ohsfeldt RL, Boyle RG. Tobacco excise taxes and rates of smokeless tobacco use in the US: an exploratory ecological analysis. *Tobacco Control* 1994;3(4):316-23.

Ohsfeldt RL, Boyle RG, Capilouto EI. Effects of tobacco excise taxes on the use of smokeless tobacco products. *Health Economics* 1997;6(5):525-32.

Ohsfeldt RL, Boyle RG, Capilouto EI. *Tobacco Taxes, Smoking Restrictions, and Tobacco Use.* National Bureau of Economic Research Working Paper Number 6486, 1998.

Orphanides A, Zervos D. Rational addiction with learning and regret. *Journal of Political Economy* 1995;103:739-58.

Pekurinen M. The demand for tobacco products in Finland. *British Journal of Addiction* 1989;84:1183-92.

Pekurinen M. *Economic Aspects of Smoking: Is There a Case for Government Intervention in Finland?* Helsinki: Vapk-Publishing, 1991.

Schelling TC. Self-command in practice, in policy, and in a theory of rational choice. *American Economic Review* 1984;74:1-11.

Sumner DA. Measurement of monopoly behavior: an application to the cigarette industry. *Journal of Political Economy* 1981;89(5):1010-9.

Sung H-Y, Hu T-W, Keeler TE. Cigarette taxation and demand: an empirical model. *Contemporary Economic Policy* 1994;12(3):91-100.

Sunley EM. *The Design and Administration of Alcohol, Tobacco and Petroleum Excises: A Guide for Developing and Transition Countries.* Washington DC: International Monetary Fund, Fiscal Affairs Department, 1998.

Suranovic SM, Goldfarb RS, Leonard TC. An economic theory of cigarette addiction. *Journal of Health Economics*, forthcoming.

Sweanor DT. *Global Cigarette Taxes and Prices.* Ottawa (Canada): Smoking and Health Action Foundation, 1997.

Sweanor DT, Martial LR. *The Smuggling of Tobacco Products: Lessons from Canada*. Ottawa (Canada): Non-Smokers' Rights Association/Smoking and Health Action Foundation, 1994.

Tauras JA, Chaloupka FJ. Price, clean indoor air laws, and cigarette smoking: Evidence from longitudinal data for young adults. Presented at the 74th Annual Conference of the Western Economic Association, Lake Tahoe, NV, July 1998.

Thompson ME, McLeod I. The effects of economic variables upon the demand for cigarettes in Canada. *Mathematical Scientist* 1976;1:121-32.

Thursby JG, Thursby MC. *Interstate Cigarette Bootlegging: Extent, Revenue Losses, and Effects of Federal Intervention.* National Bureau of Economic Research Working Paper No. 4763, 1994.

Townsend JL, Roderick P, Cooper J. Cigarette smoking by socioeconomic group, sex, and age: effects of price, income, and health publicity. *British Medical Journal* 1994;309(6959):923-6.

US Department of Health and Human Services. *The Health Consequences of Smoking: Nicotine Addiction. A Report of the Surgeon General.* Rockville (MD): US Department of Health and Human Services, Public Health Service, Centers for Disease Control, Center for Health Promotion and Education, Office on Smoking and Health, 1988. DHHS Publication No. (CDC) 88-8406.

US Department of Health and Human Services. *Preventing Tobacco Use Among Young People: A Report of the Surgeon General.* US Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health. Washington: US Government Printing Office, 1994.

van der Merwe R. The economics of tobacco control in South Africa. In: Abedian I, van der Merwe R, Wilkins N, Jha P, eds. *The Economics of Tobacco Control: Towards an Optimal Policy Mix.* Cape Town: University of Cape Town and the World Bank, forthcoming.

Warner KE. Tobacco taxation as health policy in the Third World. *American Journal of Public Health* 1990;80:529-531.

Warner KE, Chaloupka FJ, Cook PJ, Manning WG, Newhouse JP, Novotny TE, Schelling TC, Townsend J. Criteria for determining an optimal cigarette tax. *Tobacco Control* 1995;4:380-6.

Wasserman J, Manning WG, Newhouse JP, Winkler JD. The effects of excise taxes and regulations on cigarette smoking. *Journal of Health Economics* 1991;10(1):43-64.

Winston GC. Addiction and backsliding: a theory of compulsive consumption. *Journal of Economic Behavior and Organization* 1980;1(4):295-324.

Xu X, Hu T-W, Keeler T. Optimal cigarette taxation: Theory and estimation. Working Paper, Department of Economics, University of California, Berkeley, CA, 1998.

Young, T. The demand for cigarettes: alternative specifications of Fujii's model. *Applied Economics* 1983;15:203-11.