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Cigarette Taxes to Fund Health Care Reform: An Economic Analysis

Jane G. Gravelle
Senior Specialist in Economic Policy
Office of Senior Specialists

and

Dennis Zimmerman
Specialist in Public Finance
Economics Division

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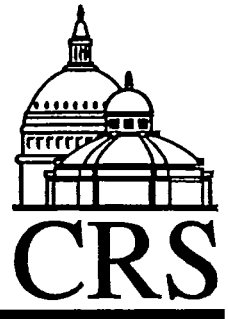

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Cigarette Taxes to Fund Health Care Reform: An Economic Analysis

Executive Summary

A cigarette excise tax increase of 75 cents per pack has been proposed to finance part of the President's universal health care program. The tax enjoys considerable public support, would raise about $11 billion per year, and would be relatively simple to administer because it would increase an existing manufacturer's excise tax. The President's fiscal year 1995 budget stressed that the tax would help pay for the additional health care costs of smoking, and would discourage individuals, particularly young people, from smoking.

This report discusses these rationales, as well as other effects of and concerns about the tax, organized into the topics of market failure as a justification for the tax (i.e., economic efficiency); potential for revenue; equity; and the job loss the tax might cause in tobacco growing regions.

One reason economic theory suggests selective excise taxes generally are not desirable is that they distort individual choices among goods and services in the market and impede efficient resource allocation. Circumstances may exist, however, in which the efficiency case against selective excise taxes is stood on its head: should market failure be present, such taxes may actually be the preferred policy instrument to achieve economic efficiency. Such market failures may exist for cigarettes for two reasons: spillover effects and imperfect information. A cigarette tax is efficient if it forces smokers to pay for costs they impose on nonsmokers (external costs or spillover effects) or if it raises smokers' costs to compensate for the effect that incomplete information has on their judgment about the cost to themselves (internal costs).

An initial question is whether the spillover effects alone are sufficient to justify the proposed increase in the excise taxes (Federal and State), which currently average 50 cents per pack. Estimates of per-pack spillover effects require information on smoking-related health care costs, sick leave costs, life insurance costs, costs of fires, foregone tax revenue, costs of pensions, and costs of nursing homes. Many of these components are subject to considerable uncertainty due to often conflicting scientific evidence, the less-than-perfect data used for measurement, and the presence of some nonquantifiable factors.

These uncertainties produce a wide range of estimates of per-pack spillover effects. Mid-range estimates based upon likely assumptions suggest net external costs from smoking in the range of 33 cents per pack in 1995 prices, an amount that by itself is too small to justify either current cigarette taxes or the proposed tax increase. An upper-bound estimate of net external costs would justify current cigarette taxes and some or all of the proposed 75 cent tax increase. A lower-bound estimate suggests smoking does not impose external costs on nonsmokers, but rather provides net external savings to the nonsmoking population (primarily because smokers' early death leaves their Social Security and pension contributions unused and available to reduce future financing demands on nonsmokers).

One controversial component of the spillover effect calculation is passive smoking. The epidemiological evidence on the health effects of passive smoking is far less certain than evidence on the effect of active smoking. In addition, any effects may be more likely to occur within families (and on spouses rather than children). This leaves two critical issues unresolved: the magnitude of the passive smoking effect; and whether the effect should be classified as an internal or external cost. If one resolves these and several related conceptual and estimating issues in favor of the option that would produce the largest passive-smoking effect, external costs from passive smoking would be approximately 21 cents per pack. Resolving these issues in a manner that weighs the uncertainties of both overestimation and underestimation would produce external costs from passive smoking as low as zero to four cents per pack.

Considering passive-smoking effects to be external costs raises an additional policy issue if a tax is used to compensate for the external costs of smoking. Available evidence suggests the majority of smokers will not be deterred by the tax. As a result, the majority of spouses and children of these undeterred smokers will not benefit from reduction of passive-smoking effects, but will be penalized because the tax will reduce their disposable family income. In this case, the tax would accomplish the opposite of what was intended.

These estimates of spillover effects are confined to effects that can be quantified—they do not account for factors such as the general distaste many individuals feel for smoking. Regulation rather than taxation might be best suited to deal with these spillover effects. No value of "distaste" exists to provide guidance on the correct magnitude of the tax, the tax must be paid for smoking even when no repelled observers are present, and it is relatively easy to separate smokers and nonsmokers in many business and social settings. In fact, it is arguable that a more efficient outcome may occur if private business regulates smoking without formal government regulation.

Some argue these estimates of net external costs are inaccurate because they do not account for the intangible costs of premature death (e.g. the grief of family and friends). On the efficiency grounds being discussed here, the relevance of this issue depends upon whether the individual accurately values the effect of this risk on his family and friends. There is no compelling reason to believe individuals, on average, undervalue this risk. In any case, a policy that assigned an arbitrary value for the underassessment of intangible cost of premature death would have far-reaching implications. It would imply imposition of the rights and preferences of groups relative to those of individuals, a policy that could be viewed as inconsistent with certain basic political and economic values of society. Pleasure driving, many recreational activities, some dietary practices, and some occupations, to name just a few activities, involve the same actuarially-validated risks of premature death and grief. In fact, we do not impose taxes on these activities. Taxing such activities involves value judgments that are beyond the scope of economic analysis.

A tax also may be justified on grounds of market failure if smokers have imperfect information about the health hazards of smoking or about the

difficulty of quitting in the future. Although surveys suggest that some smokers are not aware of or do not accept the health hazards of smoking, available data indicate the average smoker is aware of, or overestimates, the health risks of smoking. Thus, there is considerable evidence that smokers seem to make their smoking decision with knowledge about the health risks of smoking.

Evidence on the adequacy of information about the difficulty of quitting is mixed. The major policy concern with this aspect of market failure is its effect on young people who are less capable of making informed decisions. Imposition of a tax to correct for their lack of understanding of the habit-forming nature of smoking would likely be effective in reducing their participation; it also would penalize a much larger number of adult smokers. Non-tax mechanisms, such as educational programs and strengthened enforcement of laws restricting sales to minors, might be better suited to deal with the problem.

While the available evidence will not support precise findings or conclusions, the proposition that efficiency improvements justify the proposed tax is subject to question: existing taxes exceed some reasonable estimates of the social cost of smoking; and the average smoker appears to have made the smoking decision while in possession of adequate information, at least with regard to health hazards. For those smokers who make poor decisions because of inadequate information, such as the young, increased education and regulation might be more effective market corrections and have fewer undesirable economic effects than a tax.

The cigarette tax would provide a significant source of revenue. However, the unindexed cigarette tax will finance a continually smaller share of health care costs. Even if the tax is indexed, the relatively high sensitivity of youth smoking rates to the tax increase will cause the total smoking participation rate to fall gradually over time. This declining total smoking participation rate will cause long-term cigarette tax revenue to fall gradually over time. After fifteen years revenue would be about ten percent less than the initial $11.4 billion annual budget-window estimate. Without further increases in the tax rate, after many years, the revenue would decline to about two-thirds of the budget-window estimate. This effect on revenue is separate from the effect that would result should there be a continuation of the long-term downward trend in smoking participation rates that is attributable to non-tax-related causes.

Equity is also an important consideration in the evaluation of tax proposals; this issue has been addressed extensively with respect to tobacco taxes in other studies. The cigarette tax is not horizontally equitable; it imposes higher taxes on smokers than on nonsmokers of equal income. The tax also is regressive, imposing larger taxes as a percent of income on lower-income individuals.

The publicized claim of 273,000 lost jobs from the cigarette tax in the health care proposal includes job losses from the export share of the market that will not be affected by the tax, losses that would be offset by Government spending, and losses from workers who shift to new jobs. After eliminating job

losses from these sources, tobacco-related job losses are estimated to be: about 7 percent of total tobacco-related jobs in North Carolina, 0.2 percent of total State employment; about 8 percent of total tobacco-related jobs in Kentucky, 0.3 percent of total State employment; and about 9 percent of total tobacco-related jobs in Virginia, less than 0.1 percent of total State employment. Even large regional multipliers would be unlikely to increase these total shares of State employment beyond one percent. Short-term regional job losses should not necessarily determine national policies, although losses can be significant in local areas, and some transition assistance or phase-in of the tax might be justified.

If the Congress is interested in exploring alternatives to cigarette tax financing, several are available. An alcohol tax would appear to be more efficient and more equitable: the best estimate of alcohol's net external cost exceeds current tax levels; alcohol taxes are also regressive but less so than cigarette taxes. Increased income tax rates or base broadening would be more equitable, and a base-broadening option such as taxing employer-paid health care premiums also would promote economic efficiency in the health care market. Elimination of some spending provisions in the health care proposal could reduce the need for revenue and promote economic efficiency, e.g., the small business subsidies for mandated premiums.

The President's budget proposal stressed the adoption of a cigarette tax to decrease youth participation as one of its rationales. Recent research suggests increased regulation and increased enforcement of existing regulations against sale of cigarettes to minors might be effective, and would avoid the adverse economic consequences that cigarette taxation imposes on the mature smoking population. Should taxation remain the preferred deterrent, greater reductions in smoking might be obtained if the tax was cut loose from the health care program and its revenue earmarked for increased antismoking regulatory and education efforts, perhaps including a system of grants to the States. Such earmarking was a feature of California's 25 cent per-pack tax that was enacted in 1989.

CONTENTS

Cigarette Taxes to Fund Health Care Reform: An Economic Analysis

President Clinton presented a comprehensive plan for universal health care in September 1993. Among the sources of financing proposed in this plan is an increase in taxes on tobacco products at a rate of $12.50 per pound of tobacco content. Virtually all of the tax (96 percent) would be collected on cigarettes. If adopted, this tax would raise the Federal cigarette tax by 75 cents per pack, from the current 24 cents to 99 cents. The tax increase is about 42 percent of the current price (inclusive of existing Federal and State-local taxes).

The tobacco tax, expected to raise around $11 billion a year, will finance a significant portion of the President's proposed health care plan as presented in the FY 1995 budget, particularly in the first year or two. It is a relatively simple tax to administer, as it increases a currently existing manufacturer's excise tax. The tax enjoys considerable public support and may be viewed by some to be the most politically feasible alternative available. Reasons given in the budget document for including the tax are the additional health care costs of smoking which the tax will help pay for and the desire to discourage individuals, particularly young people, from smoking.[1]

This report discusses these rationales as well as several concerns that have been raised about this proposed tax. First, selective excise taxes normally are not rated as desirable revenue sources because they distort consumption decisions. A cigarette tax, however, may be desirable if it compensates for burdens that smokers impose on others or because smokers make their smoking decision without adequate information to assess the health costs of smoking. In fact, the choice of a tax on tobacco to finance health care may have been motivated by both of these links between smoking and poor health. If smokers generate additional health costs, some of which nonsmokers pay, why not impose a tax on smokers to offset the burden they impose on nonsmokers? And if smokers make inadequate risk assessments, shouldn't they be discouraged from smoking? Whether these conditions, or market imperfections, are present is an empirical question addressed in section I.

Second, the health care program is to be a permanent program and the permanence of its financing sources is of interest. Section II investigates the effect of several factors on the long-term adequacy of cigarette tax revenue: the lack of indexing of the tax; the long-term deterioration of smoking participation rates; and per capita income growth.

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[1] *Budget of the United States Government, Fiscal Year 1995*, Washington, D.C.: United States Government Printing Office, p. 187.

A third issue is the potential loss of jobs in the tobacco industry and the concentration of these lost jobs in regions of the country that are heavily dependent on the growing of tobacco and the manufacture of tobacco products. Section III discusses the conceptual and empirical foundation for these industry and regional effects.

A fourth issue is the regressivity of this excise tax (that it takes a higher fraction of income of lower-income individuals) and that it also tends to impose different amounts of tax on people who, by virtue of having equal income, are generally considered to be equals. These effects are well documented by numerous studies, and this equity issue is discussed briefly in section IV.

Section V discusses policy implications arising from the analysis. Appendix A discusses the evidence on passive smoking, Appendix B compares the estimating procedures for various studies of the external costs of smoking, and Appendix C explains the model used to calculate long-term cigarette tax revenue.

I. MARKET IMPERFECTION AS A JUSTIFICATION FOR TAXING TOBACCO

One reason economic theory suggests selective excise taxes generally are not desirable is that they distort individual choices among goods and services in the market and impede efficient resource allocation. Circumstances may exist, however, in which the efficiency case against selective excise taxes is stood on its head: should market failure be present, such taxes may actually be the preferred policy instrument to achieve economic efficiency.

This section discusses two conditions that, if present, make a selective excise tax on cigarettes and other tobacco products a correction for market failure and consistent with economic efficiency: spillover effects and imperfect information. First, cigarette smoking might impose a financial burden on the rest of society (spillover effects). Second, people might make their smoking decision without complete information about the negative consequences of these products; that is, they may make a rational decision based on imperfect information that would be irrational given complete information.

SPILLOVER EFFECTS

It is a generally accepted fact that smoking damages the smoker's health. The term "health costs" is a broadly defined measure which includes medical expenditures, lost productivity from sickness and disability, and early death. These health costs are divided into two types—those that burden the smoker himself (internal costs) and those that burden society (external costs).[2] If the smoker possesses complete information about the relationship between smoking and his own health, he already takes internal health costs into account in making a decision, and no tax is justified to obtain economic efficiency. It is, therefore, the external health costs that might justify cigarette taxation. This section deals with the magnitude of external costs, or spillover effects. The following section deals with the issue of whether imperfect information about internal costs justifies a tax.

To the extent that others in society must pay part of these health costs—increased medical expenditures (which are largely pooled through insurance), and increased job absences covered by sick leave payments—a tax may be justified because the cigarette price does not cover the true economic cost of smoking. And the external costs of smoking are not limited to the health costs of smokers. For example, smoking contributes to fires whose costs may be borne by others if premiums on fire insurance are raised for everyone.

This brief discussion suggests two conclusions from standard economic theory. First, smoking-related costs that are incurred by the smoker

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[2] These issues are also discussed in Michael Gross, Jody L. Sindelar, John Mullahy, and Richard Anderson, "Policy Watch: Alcohol and Cigarette Taxes," *Journal of Economic Perspectives*, Vol. 7, Fall 1993, pp. 211-222.

directly—such as his share of medical expenditures or actual lost wages from sick days— are internal costs that do not justify a tax on spillover grounds. Second, costs imposed on the nonsmoking population (external costs) can justify a tax on spillover grounds. This conceptual case for cigarette taxation does not, however, provide information about how large the tax must be to compensate for the external costs. For that, it is necessary to review the literature that measures the magnitude of these external costs.

The Manning Study

A thorough analysis of spillover effects from smoking must include a lifetime profile of both the external costs smokers impose on nonsmokers and the external savings smokers provide to nonsmokers. While there has been considerable research on the overall health costs of smoking (medical expenditures, lost productivity from sickness and disability, and early death), only the study by Manning, Keeler, Newhouse, Sloss, and Wasserman (hereafter referred to as the Manning study) measures both the lifetime external costs and savings that are needed to gauge the efficient excise tax.[3] Their study uses data on health costs of smokers (both current and former) and lifetime nonsmokers (referred to as never-smokers) to develop the estimates.

The Manning study found that the net external costs (external costs minus external savings) of smoking are small—smaller than the current combined Federal and State taxes on cigarettes. Part of the reason for this finding is that the external costs smokers impose on society (primarily because their larger lifetime medical expenditures are not reflected in the insurance premiums they pay or in contributions to programs such as Medicare) are substantially offset by the external savings they provide to society: their earlier death reduces their payout from the pension plans (including social security) to which they

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[3] See Willard G. Manning, Emmett B. Keeler, Joseph P. Newhouse, Elizabeth M. Sloss, and Jeffrey Wasserman, *The Costs of Poor Health Habits*, A RAND Study, Cambridge, Mass.: Harvard University Press, 1991. The results for alcohol and tobacco appear also in "The Taxes of Sin: Do Smokers and Drinkers Pay Their Way?", *Journal of the American Medical Association* v. 261, March 17, 1989, pp. 1604-1609. The basic data for the study are from the Health Insurance Experiment conducted by the RAND corporation for individuals under age 60 (collected from years 1972-1982), supplemented with data from the 1983 National Health Interview Survey for older individuals. Data are expressed in 1986 dollars.

contribute.[4] (These pension plan savings are smaller than they would otherwise be because smokers retire earlier than non-smokers.)

In 1986 dollars, the Manning study found that the net external cost per pack of cigarettes is 15 cents for a new (young) smoker. This estimate includes 43 cents of external costs imposed on society: 26 cents of additional medical expenditures; one cent of sick leave costs; 5 cents of group life insurance costs; 2 cents of costs from fires; and 9 cents of lost tax revenue smokers would have paid to finance retirement and health programs had they not died early. Offset against these costs are external savings to society of 27 cents: 24 cents from reductions in retirement pensions; and 3 cents from reduced use of nursing homes. Rounding error accounts for the lost cent.

This 15 cents of net external costs equals 21 cents in 1995 dollars if the spillover effects are adjusted using the GNP deflator; and 33 cents if the medical expenditure and nursing home components of external costs are adjusted using the medical services price index.[5] (Unless otherwise stated, the 1995 estimate using this medical services price index will be used for all further per-pack calculations in this report.) The 50-cent current tax (Federal tax of 24 cents per pack and average State and local taxes of 26 cents per pack) is 1½ times as high as the 33-cent tax justified by the net external costs estimated in the Manning study.[6]

Notably, the Manning study suggests a much stronger case can be made for taxing alcoholic beverages at a higher rate. It estimates net external costs of at least 68 cents per ounce of alcohol.[7] A large fraction of this cost is associated with loss of life, medical expenditures, and property damage in automobile accidents. Current Federal taxes on alcohol are $13.50 per proof gallon, or

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[4] Note that counting these reduced costs of pension plan payouts as transfers to the nonsmoking population does not mean that there is a gain to society from premature death—such premature deaths are costly. That is, transfers have no effect on the total cost (to smokers and nonsmokers combined) of premature death. Because transfers are made, the cost of premature death to the smoker (internal costs) has increased—the retirement income the smoker is losing is higher. Costs to nonsmokers (external costs) are decreased by the same amount. This accounting for transfers must be made in order to analyze separately the two potential market failures identified in this report, spillover costs and imperfect information. Some have suggested that this treatment implies that society benefits from early death, and that, for example, early deaths from breast cancer would be treated as a savings when evaluating the desirability of breast cancer research. This analogy is not correct. In the case of breast cancer research, the reduction in premature death would obviously be treated as a benefit to society.

[5] These adjustments use the GNP deflator as projected by the Congressional Budget Office. The medical services price index is taken from actual data for 1986-1992; for additional years, the assumption is made that these costs rise in excess of the GNP deflator by the difference observed from 1986-1992.

[6] The average State and local tax of 26 cents per pack was reported in Tax Foundation, *Tax Features*, vol. 37, October 1993.

[7] There was not enough division of costs to separate out the medical expenditures component of traffic accidents, so the cost could be a few cents higher.

about 21 cents per ounce for distilled spirits; $18.00 per barrel of beer, or about ten cents per ounce; and $1.07 per gallon on table wine, or about eight cents per ounce. State taxes tend to be low (ranging from less than two cents to about ten cents per ounce for distilled spirits, generally less than one cent per ounce for beer, and from less than two cents to about 16 cents per ounce for wine).[8]

These data suggest that much larger taxes would have to be imposed on all of these products if alcohol taxes were to reflect net external costs.[9] In short, based on the criterion of matching tax revenue to net external costs, the data indicate that cigarettes are overtaxed and alcohol is undertaxed.[10]

Qualifications to the Manning Study

Because the Manning study is alone in its attempt to calculate all financial spillover effects (both costs and savings) as a basis for assessing the economically efficient level of tax, it is important to discuss thoroughly potential issues that may raise doubts about the results. This section considers a variety of such issues: the likelihood of estimation error from model specification; the sensitivity of the estimate to the choice of discount rate; the omission of passive smoking from the external cost estimate; the proper treatment of non-health-related external costs; some miscellaneous issues; and the consistency of the estimate with findings of related studies. Many of these issues and caveats are also discussed in the Manning study.

Much of this discussion is quite technical and is presented below. A brief summary of these issues is provided for those readers who may wish to skip the technical details and proceed directly to the information and addiction discussion in the next section.

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[8] These are rates as of September 1992, as reported in Tax Foundation, *Facts and Figures on Government Finance*, 1993, pp. 256-57. Some States do not allow private sale and typically impose taxes as a percentage of price; note also that the higher tax rates on wine are imposed only in a very few States; most States impose taxes well below the Federal level.

[9] Some argue that significant differences exist between alcohol and tobacco in that some alcohol is consumed in moderate amounts by individuals who do not drive while intoxicated. This nonabusive consumption does not generate external costs and should not be subject to an excise tax whose purpose is to correct for externalities. It is also true, however, that the magnitude of external effects from tobacco depends in part on the amount of exposure in packs per day and the number of years smoked. Those who smoke for a short period are more similar to nonsmokers than to smokers in their health and mortality characteristics. Obviously, use of an excise tax as an instrument to correct for external costs is imperfect for both alcohol and tobacco.

[10] Some might ask why this report does not evaluate the other major selective excise revenue raiser, the gasoline tax, as a substitute revenue source for cigarette taxation. A primary rationale for both alcohol and cigarette excise taxation is control of socially undesirable (costly) behavior. The primary rationale for the gasoline tax is to require highway users to provide tax revenue in exchange for the benefits they receive from highway construction.

- Estimation error—The Manning study's lower-bound and upper-bound estimates of spillover effects are designed to account for the possibility of estimation error. The lower-bound estimate produces net external savings of 14 cents per pack (recall that all estimates are adjusted to 1995 price levels). The upper-bound estimate produces a net external cost of 53 cents. Neither of these estimates justify a 75-cent increase in the cigarette tax which currently averages 50 cents per pack.

- Discount rate—Any study whose results involve a comparison of costs and savings with significantly different time patterns can alter the relative magnitudes by changing the discount rate. Raising the discount rate from five to ten percent would increase net external costs of smoking to 42 cents per pack. Lowering the discount rate to just under four percent would produce net external costs of zero; below that rate net external savings would be generated. In neither case is a 75-cent increase in the tax rate justified on spillover grounds.

- Passive smoking—Differences exist about whether passive smoking effects are largely internal or external costs. The link between passive smoking and disease is uncertain. The best available estimate of this link implies external costs of no more than a few cents per pack, not enough to justify a 75-cent increase in the cigarette tax.

- Non-health-related external costs—The Manning study does not incorporate effects such as general distaste and annoyance on the part of many for smoking. These effects cannot be quantified and may be best dealt with through regulation rather than taxation.

- Relationship of the Manning study to other studies—The Manning study is likely to be more accurate in its estimates of the economically efficient level of tax because it is the only study that uses the appropriate analytical framework and includes all financial spillover costs. Other studies, when considered in the appropriate framework, are generally consistent with the Manning study.

1. Estimation error from model specification

The Manning estimate uses a procedure that attributes variations in individuals' total lifetime health costs to smoking status, income, sex, and various other attributes. This is a standard estimation strategy—it attempts to control for the influence of nonsmoking factors on total health costs, thereby isolating the influence of smoking. This is referred to as the "base case" in the following discussion.

The Manning study estimates an upper limit for the external costs of smoking that arise from effects on smokers' health by attributing all the variation in total health costs among individuals to smoking status, in effect assuming that no other differences among individuals contribute to the observed

differences in health costs. This "upper-bound" analysis produces net external costs of 53 cents. This cost is likely to be an overestimate since some of the deleted nonsmoking factors are found to be statistically significant and therefore are likely to have some influence on total health costs. With this upper-bound case, the conceptually desirable tax (on efficiency grounds) would argue for only a three-cent increase in selective cigarette excise taxes.

It also is possible that the 33-cent net external cost estimate, based upon total health costs, is an overestimate. This would occur if omitted variables generate nonsmoking health costs that happen to be correlated with smoking. Consider risk. Smokers are found to be more likely to engage in risky activities and as a consequence are, for example, more likely to incur health costs from accidents.[11] These nonsmoking health costs to some extent would be attributed to smoking status by the base-case methodology, even though they are caused by differences in risk-taking rather than smoking status.

The Manning study's authors attempt to control for such bias by restricting health costs to those thought to be related to the smoking habit (e.g., certain cancers, respiratory illness, circulatory diseases, and ulcers). Using this approach, they construct a "lower-bound" estimate that also eliminates any effect of smoking on early retirement (which affects the level of pensions and foregone taxes). Attributing variations in these smoking-related or habit-related health costs to smoking status, income, sex, etc., and eliminating the retirement effect, produces net external *savings* (external savings exceed external costs) of 14 cents. Of course, if smoking produces net external savings rather than a net external cost, a cigarette tax justified as compensation for net external costs would not be appropriate.

If medical expenditures are adjusted only to reflect habit-related disease, but unlike the case just discussed the effect on early retirement from the base case is retained, the result is a net external cost of 12 cents. If instead early retirement costs in the base case are reduced in the same proportion as the reduction in the change in medical expenditures moving from the base case to the lower bound, the result is net external savings of four cents.

What is one to make of these three cases and their permutations? The upper-bound case seems unrealistic—it comes from a clearly misspecified model that attributes too many health costs to smoking, yet still produces estimates of net external costs that fall far short of justifying a 75-cent tax increase. The lower-bound estimate (and estimates adjusted to various treatments of early retirement) could be a better estimate of spillover effects than the base case. If the base-case model were perfectly specified (no omitted variables), it would provide the same results for medical expenditures as the lower-bound case (provided the latter correctly identified smoking-related health costs). Which model provides a better estimate of spillover effects depends upon one's belief about whether omitted variables in the base case are more of a problem than the

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[11] See W. Kip Viscusi, *Smoking: Making the Risky Decision*. New York: Oxford University Press, 1992.

measurement error incurred when separating smoking-related health costs from total health costs.[12] Neither justifies the current 50-cent cigarette excise tax on the basis of spillover effects.

2. Choice of discount rate

Any study whose results involve a comparison of costs and savings with significantly different time patterns can alter the relative magnitudes by changing the discount rate. Discounting provides a way to compare, at a given point in time, amounts that will be received at different points in the future. Discounting accounts for the fact that a dollar received or spent in the future is less valuable than a dollar received at present, since a dollar received now can be invested at interest. The higher the interest (discount) rate, the smaller the value of amounts paid or received in the future.

Discounting is important in the Manning study because the external costs of smoking accrue more quickly across time than do the offsetting external savings from smoking. Thus, the relative importance (dollar value) of external costs and external savings is affected by the choice of discount rate. Also, much of the tax is paid in advance of either the savings or the costs.

Raising the discount rate from the five percent used in the base case to ten percent increases the difference between the external costs and the offsetting external savings from 33 cents to 42 cents. A further increase in the discount rate has little effect on net external costs, because at a ten percent discount rate, future external savings are already so heavily discounted that further discounting has a minor effect. Also, all values are reduced relative to tax receipts, which occur earlier in time. Lowering the discount rate has a more powerful effect: external costs equal external savings (net external costs become zero) at a discount rate of slightly under four percent (and at a zero discount rate, smoking produces external savings of $1.18 a pack).

A zero discount rate is not reasonable, but the ten percent rate is probably too high. A discount rate reflecting the pre-tax return on capital would probably be around seven percent, or about halfway between the five percent and ten percent levels.[13] Because of the way in which discounting affects net external savings, the seven percent discount rate produces results that are very close to

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[12] These measurement errors could arise from imperfect medical knowledge or from misdiagnosis of illness. The direction of such a measurement error is not clear. For example, some smoking-related illnesses could be diagnosed as a non-smoking-related disease because smoking is a contributing rather than primary cause. At the same time, physicians may be more inclined to diagnose as smoking related the illnesses of smokers than those of non-smokers. See Hans J. Eysenck, "Smoking and Health," in *Smoking and Society*, ed. Robert D. Tollison, Lexington: D.C. Heath, 1986 for a discussion of evidence on this latter effect.

[13] This seven percent rate of return is consistent with two methods of derivation: dividing estimated net capital income by the estimated capital stock, and grossing up an estimated after-tax return by the estimated effective tax rate.

the ten percent rate. None of these discount rates generate net external costs that justify current excise tax rates.

3. Passive smoking

Some suggest the Manning study underestimates net external costs from smoking because it does not include the external costs of passive smoking. The exclusion of these effects is not due to a failure to address the issue. These issues are addressed in a variety of ways in the Manning study. With respect to the data used to estimate costs for active smokers, the Manning study cuts its medical expenditure data eight ways in a search for evidence of passive smoking effects. It examines both total medical expenditures and the subset associated with illnesses related to smoking, for adults and children as outpatients and inpatients. The data analyzed indicate a statistically significant effect for habit-related (smoking-related) inpatient medical expenditures for adults; the data do not indicate an effect for the other categories.

Several reasons suggest it may be appropriate to omit passive smoking effects from the calculation of the corrective tax: first, there is much less certainty about the link between passive smoking and health than the link between direct smoking and health; second, to the extent that evidence does exist, it has been associated with effects within families and largely to spouses of smokers, thereby raising questions as to whether the effect should be considered an external or an internal cost; third, taxes may be a flawed instrument to correct for passive smoking effects; and finally, based on available evidence, these costs are quite small relative to current and proposed taxes. Each of these points is discussed.

First, the effects of passive smoking on health are far weaker and less certain than the effects of active smoking. There has been a debate about passive smoking's effect on health; much of the discussion about this issue is technical in nature and is discussed in Appendix A.

Second, if a passive smoking effect exists, the effect may be most likely to occur within families.[14] Reasons exist for considering a family, rather than an individual, to be the decision-making unit when designing externality-correcting taxes. One reason is that corrective governmental action often is not desirable for spillover effects that occur within groups that are small enough to negotiate with each other, since members of the group can come to a mutual agreement that maximizes welfare. Passive-smoking effects that occur within a family unit may fit this description. This is a gray area where public policy might well consider these effects either as internal or as external costs depending upon the

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[14] Although the Environmental Protection Agency issued a risk assessment that classifies environmental tobacco smoke as a cancer-causing agent, the epidemiological studies they use are based on studies of passive smoking within the home, not in the workplace or in public places. See United States Environmental Protection Agency, *Respiratory Health Effects of Passive Smoking: Lung Cancer and Other Disorders*, December 1992.

relative bargaining strengths of those affected. The findings of the Manning data, which tend to show that costs are more likely to be associated with adults (who presumably have relatively comparable bargaining strengths) than with children (who presumably would operate from a relatively weak bargaining position) might argue for treatment as internal costs. In addition, since smoking tends to be initiated at an earlier age than marriage, individuals generally know whether or not their spouses will be smokers.

If the smoker or the parents together make the decisions and there are effects on children, there is still a reason to treat costs as internal. Many, one hopes most, parents consider the welfare of each other as well as children in making decisions. Thus, many family smokers should already be taking into account, at least in part, any negative consequences of smoking for other family members, regardless of how decisions are made.

Third, if passive smoking effects are considered external costs, equity considerations suggest a tax remedy may not be desirable. The justification for a tax to correct externalities is made on efficiency grounds because it is *possible* to make all individuals better off. This "all win" scenario is accomplished (assuming a net external cost) by: (1) imposing the tax on cigarette smokers, thereby reducing their after-tax income; (2) altering smokers' behavior, thereby making nonsmokers better off; and (3) making lump sum payments to compensate smokers for their tax payments. In practice, the third step is omitted, which causes distributional effects—smokers lose and nonsmokers gain. Many people, however, perceive this distributional effect as fair, since smokers impose costs on nonsmokers in the first place. Were a tax used to correct spillover effects within families, however, nonsmoking family members in families with smokers who continue to smoke will be made worse off—they receive little or no reduction in passive smoking costs and their after-tax income is reduced by the amount of the family's tax payments. Thus, while a tax to reflect such passive-smoking costs might be efficient, these equity considerations may make it less desirable.

Finally, even if all costs of passive smoking are considered to be external and existing data are used to measure a per pack amount, the costs probably are small relative to current and proposed taxes. The Manning study calculates a total cost of smoking (both external and internal costs in excess of the price of the product) that includes medical expenditures, lost productivity due to illness, lost productivity due to early death, and costs from fires. This total cost equals $2.53 per pack (recall that these numbers are adjusted to 1995 levels). While the literature does not provide good data on the relationship between these active-smoking costs and passive-smoking costs, and indeed does not really show for certain that a passive-smoking cost exists, these total active-smoking costs along with other data can be adjusted to make three rough estimates that are suggestive of the general magnitude of potential passive-smoking costs.

Estimate based upon EPA's estimate of deaths from lung cancer—Although the uncertainty of the epidemiological studies on passive smoking is discussed in Appendix A, these results can be used to generate possible passive-smoking

costs. Divide EPA's estimated 3000 deaths from lung cancer due to passive smoking by the lung cancer deaths attributed to active smoking, and multiply this 0.022 result by the per pack total cost.[15] This generates passive-smoking total costs of six cents per pack.

Estimate based upon EPA's estimate of child hospitalizations—A second epidemiological-based estimate can be made using EPA estimates that hospitalizations of young children due to respiratory disease from passive smoking range between 7,500 and 15,000. The average hospitalization is estimated to cost between $3,000 and $4,500.[16] If these amounts are converted into per-pack costs they would range from one-tenth to three-tenths of a cent per pack.[17]

Estimate based upon relative physical exposure to smoke—A third adjustment is to multiply the estimate of total active-smoking costs by the ratio of nonsmokers-to-smokers' physical exposure to smoke and by the ratio of nonsmokers to smokers.[18] This calculation generates a passive-smoking total cost of 2.5 to 5 cents per pack.

The first and third estimate might understate passive-smoking costs if the $2.53 per pack total active-smoking cost is understated. First, if individuals are willing to pay more than expected lost earnings for the expected change in life expectancy (internal costs for active smokers, but external costs for passive smokers), the $2.53 per-pack cost could rise by as much as $5 a pack, according to Manning. Stated in 1995 price levels, this increase could be as much as $6.84 per pack. Another difficult area to assess is the cost of low birth-weight babies due to maternal smoking. Some have argued that these passive-smoking costs

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[15] Premature lung cancer deaths attributable to smoking are estimated at 137,000 in 1989. See United States Environmental Protection Agency (1992); and U.S. Library of Congress. Congressional Research Service. *Mortality and Economic Costs Attributable to Smoking and Alcohol Abuse*, Report 93-426 SPR by C. Stephen Redhead, April 20, 1993. Note that this method assumes that the relationship between active and passive premature deaths for lung cancer holds for the overall ratio of health and mortality costs for all diseases.

[16] Testimony of Alfred Munzer, American Lung Association, Before the Subcommittee on Specialty Crops and Natural Resources of the House Committee on Agriculture, July 21, 1993, stated that 15,000 hospitalizations would cost between $45 million and $68 million.

[17] Current Federal taxes at 24 cents a pack account for $5.7 billion; thus each penny per pack is worth $238 million. The total cost of the hospitalizations would range from $23 million (7,500 at $3,000) to $68 million (15,100 at $4500). Thus, the amount per pack would be from less than one-tenth of a cent to less than three-tenths of a cent.

[18] Kyle Steenland, "Passive Smoking and the Risk of Heart Disease," *Journal of the American Medical Association*, January 1, 1992, Vol. 267, pp. 94-99 reports urinary cotinine (a marker for nicotine) in nonsmokers to be less than one percent of that of smokers, and in nonsmokers living with smokers, two percent or less. Since there are roughly an equal number of never-smokers and former/current smokers, the passive cost would be one to two percent of active smoking. These estimates may actually be somewhat high: see the discussion of biological markers in Chapter 3 of the Environmental Protection Agency (1992). Note that this method assumes a linear relationship between exposure and disease.

are very high, but measurement is difficult and only a small group of smokers (pregnant women) impose these costs.[19]

Adjusting for these higher total active-smoking costs gives passive-smoking costs of 21 cents per pack for the calculation based upon estimated lung cancer deaths and 9 to 18 cents for the calculations based upon physical exposure. These seem rather high for a few reasons. First, as stated above, the epidemiological evidence for passive-smoking-related disease is weak. Second, the estimates based upon physical exposure assume a linear relationship between exposure and disease. In fact, strongly nonlinear relationships in which health effects rise with the square of exposure, and more, have been found with respect to active smoking (see Surgeon General's Report, 1989, p. 44). For example, if health effects rise with the square of exposure, the effects would be one-tenth to one-fifth as large as with a linear relationship. Adjusting the nine to 18 cents per pack to allow for such a nonlinear relationship would reduce passive-smoking costs to a range of one to four cents per pack.

These calculations suggest that if a passive-smoking cost were to be considered appropriate for inclusion as an external cost, it would be quite small, and unlikely to raise the estimate of spillover effects above the level of the current tax. Thus, it would not justify the 75-cent tax increase.

4. Non-health-related external costs; intangible costs

Some also suggest the Manning results are understated because they do not incorporate non-quantifiable external costs such as irritation from smoke, smell, nuisance, or general distaste. This is a complicated issue whose resolution requires more than economic analysis. The distaste some individuals have for smoking is difficult to quantify. The stance society should take—whether it should protect the observer's right to be free from the sights, sounds, and smells of others, or whether it should protect the individual's right to indulge in the offending habit when there is no way to measure damage—is not subject to clear guidelines. Individuals undertake many activities that others find distasteful, and many, perhaps most, of them are not subject to government control.

In any case, a tax might not be the best approach to correct for such behavior, for choosing the efficient level of tax relies on quantification of dollar value and is imposed whether or not repelled observers are present. Rather, regulations which separate smokers, allow specific smoking areas, or restrict the

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[19] See Joel W. Hay, "The Harm They Do Others: A Primer on the External Costs of Drug Abuse," in *Searching for Alternatives: Drug-Control Policy in the United States*, ed. Melvyn B. Krauss and Edward P. Lazear, Stanford: Hoover Institution Press, 1991.

activity in close environments might be more appropriate. Such regulations have been shown to be effective in reducing the demand for cigarettes.[20]

Note, however, that an argument can be made that, to achieve efficiency, private businesses should be able to make their own decisions about allowing, disallowing, or separating smokers, since they must respond to the tastes of their customers and workers. For example, owners of restaurants and bars will modify their conditions to attract customers so that some will allow smoking, some will not allow smoking, and some might segregate smokers from nonsmokers.[21] This is a fairly straightforward argument that holds up as long as sufficient choice is available and customers have adequate information. Some decisions would still have to be made about public facilities that are subject to monopoly provision. In practice, of course, many such regulations already exist, some affecting private businesses as well as public facilities.

Some argue these estimates of net external costs are not relevant because they do not account for the intangible costs of premature death (e.g. the grief of family and friends). On the efficiency grounds being discussed here, the relevance of this issue depends upon whether the individual accurately values the effect of this risk on his family and friends (presumably relatively few individuals ignore these risks). There is no compelling reason to believe the individual undervalues this risk. In any case, a policy that assigned an arbitrary value for the underassessment of intangible cost of premature death would have far-reaching implications. It would imply imposition of the rights and preferences of groups relative to those of individuals, a policy that could be viewed as inconsistent with certain basic political and economic values of society. Pleasure driving, many recreational activities, some dietary practices, and some occupations, to name just a few activities, involve the same actuarially-validated risk of premature death and grief. In fact, we do not impose taxes on these activities. Taxing such activities involves value judgments that are beyond the scope of economic analysis.

5. Miscellaneous issues

Several other issues suggest viewing the estimates in the Manning study with some uncertainty.

(1) The estimates indicate the appropriate tax only for a new (young) smoker, not for the current mix of smokers. Ideally one might wish to tax each

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[20] Two recent studies include a "regulation index" as a determinant of the demand for cigarettes. See Theodore E. Keeler, Teh-Wei Hu, Paul G. Barnett, and Willard G. Manning. "Taxation, Regulation, and Addiction: A Demand Function for Cigarettes Based on Time-series Evidence," *Journal of Health Economics*. Vol. 12, 1993, pp. 1-18; and Jeffrey Wasserman, Willard G. Manning, Joseph P. Newhouse, and John D. Winkler. "The Effects of Excise Taxes and Regulations on Cigarette Smoking," *Journal of Health Economics*. Vol. 10, 1991, pp. 43-64.

[21] This argument is made by Robert D. Tollison and Richard E. Wagner, *The Economics of Smoking*, Boston: Kluwer Academic Publishers, 1991.

cigarette based on its marginal net external cost; such estimates do not exist and such an approach is impossible to translate into an excise tax, which cannot be varied by the age and characteristics of the purchaser. Moreover, the fact that existing smokers have already paid taxes and had their smoking decisions influenced by these taxes would need to be considered. The lifetime perspective offers the only feasible method of calculating a net external cost and the associated corrective tax. The implications of a lifetime perspective for calculating the tax receive more attention in Appendix B.

(2) Changes in the tar and nicotine content of cigarettes may result in a decrease in net external costs for current new smokers as compared to the cross section of existing smokers.

(3) The share of cost borne privately may differ in the future from the assumptions in the Manning study. In the Manning study, approximately 28 percent of the present value of lifetime medical costs and half of nursing-home costs was paid by the smoker. If there were no cost sharing, the per-pack amount would rise to 46 cents from 33 cents. The President's proposed health care plan will, however, also involve some cost sharing through deductibles and copayments. If cost sharing were 15 percent, the per-pack amount would be 37 cents; if cost sharing were ten percent, the per-pack amount would be 40 cents.

(4) The estimates include only the foregone tax revenue from early death that is used to finance transfer payments. Exclusion is clearly an appropriate decision for the remaining taxes that finance benefit-type goods, since the demand for these goods is also reduced. Exclusion may be less appropriate for those taxes that finance collectively-consumed goods (such as defense) where a reduction in the number of consumers provides no cost savings. At the same time, there are other collective non-market benefits (e.g. reduction in congestion) that are not accounted for. Their exclusion raises an interesting conceptual issue which would require subjective judgments to quantify.

(5) Interview surveys, on which some of the data are based, may be subject to considerable errors in recall. The Manning study also prepared an estimate based on the National Health Interview Survey for all ages. The 39-cent net external cost is higher due to higher sick leave costs.

(6) When comparing the spillover effects with the proposed tax at 1995 price levels, the likelihood that average State taxes would increase during that time period is ignored.

6. Relationship of the Manning study to other studies

There are other studies of the costs of smoking, particularly of the medical expenditures component of these costs, and there are other estimates of per-pack medical expenditures or total health costs. The Manning study is likely to be more accurate in its estimates of the appropriate level of tax because it is the

only study that uses the appropriate analytical framework and seeks to include all spillover costs.

Five other studies/calculations are discussed in Appendix B. Of these, two studies provide evidence on the magnitude of excess lifetime medical expenditures of smokers; the Manning study's estimate of excess lifetime medical expenditures falls between these two estimates. Others of these studies provide calculations of per-pack medical expenditures or total health costs that are inconsistent with the Manning results. The Appendix discussion illustrates the conceptual deficiencies of these estimates *as an indicator of net external costs and the corrective tax.*[22]

This section states and explains the general characteristics of the Manning study that make it conceptually correct. First, the Manning study attempts to identify all financial costs and savings of smoking that are *external* to the smoker. Thus, it includes medical expenditures and costs of lost productivity, but adjusts these costs to exclude amounts that are paid out of pocket by the smoker; that is, external costs are distinguished from internal costs. As a consequence of this procedure, it includes changes in the smoker's payments to society and society's payments to the smoker that result from the smoker's early death.

Second, the Manning study controls statistically for many other attributes that might affect observed differences in health care expenditures for smokers and nonsmokers, such as education, income, and other health habits. (This control does not necessarily, of course, capture all of these other factors.)

Third, the Manning study calculates the tax from a lifetime perspective, where costs and savings of smoking are discounted over a lifetime and used to generate a tax of equal present value. This lifetime perspective is important because of the time-dependent nature of the smoking/health phenomenon. Typically, individuals smoke for many years before smoking-related disease appears; taxes are collected well in advance of additional medical expenditures, and as a result taxes and medical expenditures have different present values. Also, when individuals die early as a result of smoking, health and other costs (e.g. pensions) are foregone (and thus reduced). These external savings (foregone medical expenditures and pension savings) occur even later in (expected) life and are even more heavily discounted than are smokers' additional medical expenditures.

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[22] It is important to note that the discussion of these studies here and in Appendix B is not meant to imply that these five studies are done incorrectly. In general, the studies are not intended to generate information suitable to estimate the efficient tax, but are simply explorations of the available data to increase knowledge about the relationship between smoking and medical expenditures. The after-the-fact comparison in this report is necessary, however, because the results of these studies are used by others to draw inferences about the efficient tax, and these inferences cast doubt upon the validity of the Manning study estimates.

Although the five studies discussed in Appendix B are useful for a variety of policy issues, they all omit at least one of these three characteristics, which renders their results for calculating the optimal tax somewhat deficient.

7. Summary

The detailed discussion of the qualifications to the Manning study suggests reasons may exist to increase and to decrease its estimates of net external costs. If all the adjustments that might suggest an increase in net external costs—a higher discount rate, passive smoking effects, a smaller share of costs borne privately, and higher lifetime excess costs found in one of the studies reviewed in Appendix B—were assumed to be appropriate, the measured external cost could be large enough to justify the 75-cent proposed tax addition.

But such an upper-limit measure does not appear to be the most reasonable choice to make. Indeed, there are adjustments that also suggest the net external cost is very small, or perhaps even net external savings—restriction of the costs to habit-related diseases, a lower discount rate, lower lifetime excess costs found in another of the studies reviewed in Appendix B. The range of reduction is at least as large as the range of increase in the numbers. The 33 cent number represents a central position between the upper and lower bounds.

Given the current state of information, Manning's base-case estimate appears to be the one that best informs the policy decision regarding the spillover effects of smoking.

INFORMATION AND SMOKING CHOICE

Aside from spillover effects, standard economic theory holds that a tax is justified on efficiency grounds if individuals are unable to recognize the full costs of smoking to themselves (internal costs). Thus, a second argument for imposing a tax on cigarettes is that people are not informed of the hazards of smoking and do not recognize the full cost to themselves. Or, they are not able to make sensible choices because the consumption of the commodity is habit-forming and they do not fully understand the difficulties of altering future behavior.

Before discussing these two issues, it is important to understand an important observation from economic theory: the fact that individuals engage in hazardous or dangerous activities does not mean that they are making bad choices. Individuals are presumed to choose activities, in accordance with their subjective tastes and preferences, that make them the happiest. This choice does not necessarily mean that they will maximize their health or their lifespan. Individuals engage in all sorts of behaviors that impose some danger in exchange for benefit (driving small cars or riding motorcycles, working in risky jobs, eating unhealthy diets, engaging in risky sports). Thus, nothing in economic theory precludes the notion that individuals smoke because their enjoyment of

the activity outweighs the sum of the actual costs of purchasing cigarettes and the internal health costs.

Some studies have found that both teenage and adult smokers tend to be risk takers in a variety of ways (e.g., they are willing to work at riskier jobs and they are less likely to wear seat belts).[23] Thus the average smoker, in continuing a behavior that involves a health hazard, seems to be behaving in a way consistent with other decisions he makes.

From an economist's perspective, if there is a market failure, it is not in making a choice to engage in a dangerous or risky activity, but rather in making that choice with incorrect information. Two aspects of this information problem are considered in turn: whether the individual is knowledgeable about the health hazards; and whether the individual understands the cost of changing behavior in the future. The final subsection discusses the policy implications of these findings.

Information on Health Hazards

An argument is frequently made that smokers may not be correctly informed about the risks of smoking. The Congressional Budget Office, for example, cited statistics indicating some smokers are not aware of the linkage between cigarette smoking and various diseases.[24]

In a recent study, Viscusi uses two surveys of the general population—his own and one provided by the tobacco industry—to quantify smokers' and nonsmokers' perceptions of the health risks of smoking.[25] The two surveys yield similar results. Survey respondents were asked how many of 100 smokers are likely to die from smoking-related diseases.

According to Viscusi, mortality statistics on smoking-related deaths indicate the total lifetime mortality risk to smokers ranges from 0.18 to 0.36 (18 to 36 of each 100 smokers are likely to die from disease caused by smoking).[26]

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[23] Viscusi (1992).

[24] Congressional Budget Office. *Federal Taxation of Tobacco, Alcoholic Beverages, and Motor Fuels*. Washington, D.C.: U.S. Government Printing Office, August 1990.

[25] Viscusi (1992). Portions of his book also appear in "Do Smokers Underestimate Risks?" *Journal of Political Economy*, vol. 98, 1990, pp. 1253-1269, and "Age Variations in Risk Perceptions and Smoking Decisions," *Review of Economics and Statistics*, vol. 73, no. 4, 1991, pp. 577-588.

[26] These lifetime estimates must be derived from annual estimates of smoking-related disease. The technique for preparing this estimate is discussed in some detail by Viscusi. It begins, however, with the basic data on annual deaths attributed to smoking. See U.S. Library of Congress. Congressional Research Service. *Mortality and Economic Costs Attributable to Smoking and Alcohol Abuse*, Report 93-426 SPR by C. Stephen Redhead, April 20, 1993 for further information on attributable deaths.

Survey respondents perceive this risk to be 0.54.[27] This perceived risk differs somewhat depending on smoking habits—0.47 for current smokers, 0.50 for former smokers, and 0.59 for those who have never smoked. The perceived risk is higher for younger ages than for older ages, probably because the young have been more heavily exposed to information on smoking and health risks. Viscusi also finds a tendency among respondents to overstate the expected number of years of life lost because of smoking.

To summarize, Viscusi finds that while smokers perceive smaller risks than nonsmokers, smokers also perceive risks to be higher than indicated by scientific evidence. Thus, while some individuals may not be aware of or may reject the evidence on the health cost of smoking, this does not appear to be the case overall. These results should not be surprising, as it is common for individuals to overestimate the risk of a highly publicized discrete event that is reported without reference to the event's frequency of occurrence in the population to whom such an event may occur (common examples are the risks of being killed by tornadoes or struck by lightning).

If individuals overestimate the health hazards of smoking, a tax would not correct for imperfect information.[28]

Information on Habit-Formation and Addiction

In addition to inaccurate risk assessment, market failure also could result if individuals incorrectly assess the impact the addictive properties of tobacco will have on any future attempt to quit.

According to the economic theories applied to addictive behavior, simply because individuals engage in behavior that involves habit formation or addiction does not mean they are making a mistake, as long as the individual recognizes the difficulty of modifying behavior in the future and the possibility of a need for such modification.[29] Individuals make many decisions that are difficult to change (and that they are probably aware are difficult to change)—marriage, job, purchasing a home, locating in a given area—without those decisions being seen as bad choices and appropriate targets for government intervention.

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[27] Much of this overestimation of risk is due to overestimation of the risk of lung cancer.

[28] Some argue that an individual's perception of risk differs when considering the risk for people as a group versus the risk for him or herself. Unfortunately, no quantitative measure exists to ascertain the extent, if any, of this difference. See U.S. Department of Health and Human Services. *Reducing the Health Consequences of Smoking: 25 Years of Progress. A Report of the Surgeon General 1989*, DHHS Publication No. (CDC) 89-8411, p. 216, hereafter Surgeon General's Report, Chapter 4 for a discussion of this issue.

[29] For a model of rational addiction, see Frank Chaloupka, "Rational Addictive Behavior and Cigarette Smoking," *Journal of Political Economy*, Vol. 99, no. 4, August 1991, pp. 722-742.

From this perspective, when smokers make a mistake it is due to a failure of information—a failure to understand either the difficulty of altering future behavior or the likelihood that alteration will be desired. It is not easy to assess the extent to which this problem occurs. A variety of observations support both the view that incomplete information is a serious problem and the view that it is a less important problem.

Two types of evidence might shed some light on the severity of this information problem. The first is evidence of the strength of the addiction problem. The less pronounced the addiction problem, the less serious is any failure to understand the problem. Second, if the addiction problem is serious, is there evidence that individuals are aware of the problem?

1. Evidence on habit formation and addiction

The evidence supporting the problem of habit formation is straightforward. That smoking is habit forming is essentially beyond dispute. There is also a substance in tobacco, nicotine, that is physically addictive to some degree.[30] A very large number of smokers say they would like to quit or have tried to quit at least once,[31] and quitters experience a high rate of recidivism.[32] Individuals also continue to spend money on smoking cessation programs.

Other observations suggest, however, that addiction is not serious enough to make smoking decisions significantly different from many other decisions in which the government does not intervene. For example, although many smokers have tried to quit and failed, many also have tried and succeeded, the vast majority without help.[33] The number of former smokers is now as large as the number of current smokers.

Smoking decisions also respond to changes in prices in a way that is consistent with consumption decisions about many other products, and increased publicity about health risks did reduce smoking substantially. Thus, individuals appear to be able to cease smoking when the price (either in actual cost or in implicit, perceived health costs) increases substantially.

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[30] This issue is discussed in U.S. Department of Health and Human Services, *The Health Consequences of Smoking: Nicotine Addiction, 1988*, Surgeon General Report, DHHS Publication No. (CDC) 88-8406. Another discussion that takes the position that there is a serious problem with physical addiction and that is written for the general public is in the chapter on smoking in Jeffrey Harris, *Deadly Choices: Coping with Health Risks in Everyday Life*, Basic Books, New York: Harper-Collins Publishers, 1993, p. 167.

[31] Seventy percent of current smokers have made at least one serious attempt to quit. See Congressional Budget Office. *Federal Taxation of Tobacco, Alcoholic Beverages, and Motor Fuels*. Washington, D.C.: U.S. Government Printing Office, August 1990.

[32] For data on relapses after quitting attempts, see Harris (1993), p. 167.

[33] Surgeon General's Report (1989).

The fact that many individuals say they would like to quit is indicative of the difficulty of breaking pleasurable habits but does not necessarily prove a serious addiction problem. As an illustration of how one might interpret discrepancies between statements of preferences and action, Viscusi notes that half of the people who live in Los Angeles say they would like to leave. The fact that they do not leave does not mean that they have no control over the decision, but rather that they perceive the benefits of staying to be greater than the benefits of leaving. Similarly, individuals may say they would like to quit, but when dealing with the actual decision continue to smoke because they enjoy it and cessation is a deprivation of an accustomed pleasure.

Indeed, some of the arguments used to support the case that smoking, addiction, and the difficulty of changing behavior is a serious problem are applicable to many other activities. Individuals not only engage in risky activities, but they also fail to initiate or persist in many behaviors that would contribute to their health (e.g. diet and exercise). When they do initiate changes, they exhibit a high rate of failure to follow through even when considerable money is spent on programs to attain these ends. Many overweight individuals have made a serious attempt to lose weight and failed; many sedentary individuals have made an effort to initiate and maintain a regular exercise program and failed. Few suggest these behaviors justify government intervention.

2. Evidence on information regarding addiction

Even if addiction is a serious problem, there is no market failure if individuals are aware of it when they make the initial smoking decision.

The argument that incomplete information is a serious problem begins with the observation that most smokers begin early in life, typically in the teenage years, when a lack of information or understanding may be more severe. A survey of teenagers showed that half expect not to be smoking in five years,[34] whereas data show that smoking participation generally does not decrease until much later in life. This evidence suggests that teenagers may well have incorrect perceptions about their ability to stop smoking.

On the other hand, some data indicate that even the very young are aware that it is difficult to quit smoking. About 75 percent of those 14 and younger, when queried about the difficulty of stopping smoking, identified as true the statement "It is very hard to stop smoking."[35]

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[34] Surgeon General's Report, 1989.

[35] Viscusi (1992). It is possible that young teenagers who smoke may have different perceptions from the average, however.

Policy Responses

The fundamental tax policy issue is twofold. If smoking decisions are assumed to be reasonably informed, then the government should not intervene beyond correcting for spillover effects. If, however, the decision is assumed not to be informed, then intervention may be appropriate and a tax might make smokers better off in the long run if it led them to quit or fail to take up the habit.

The preceding discussion suggests uncertainty about the degree to which the smoking decision is a wrong decision when it is placed in the context of individual preferences. The evidence presented suggests that there is not much of a case for a market failure with respect to information on the health hazards of smoking. Indeed, it is possible that individuals overestimate these health costs, on average. Whether individuals are informed about the difficulties of changing future smoking behavior is much less certain.

As a correction to information problems regarding addiction, a tax has certain shortcomings. First, use of a tax that is set properly requires a quantification of the degree to which information is incorrect, a measure that cannot be made based on current information and that would presumably vary widely across individuals.

Second, the tax would be an effective deterrent to smoking primarily for those who have not yet begun and for those smokers who are *least* addicted. This is not an inconsequential step, but the tax would not be an effective remedy for correcting behavior for those who have already made an uninformed choice.

Finally, as in the case of spillover effects within the family, a tax aimed at "helping the smoker" produces distributional or equity effects that blur the desirability of the policy overall. Consider, for example, a tax of the magnitude proposed by the health care plan. Based on the elasticities used in section II, the short-run participation elasticity of tobacco consumption (percentage change in share of individuals smoking divided by the percentage change in price) is about -0.3 and the long run elasticity is about -1.2. Assuming a constant elastic function with a 75-cent tax, about ten percent of individual smokers will quit smoking in the short run. In the long run, the reduction will be about a third. This is troubling because the tax makes worse off the majority of those it is intended to help, and is particularly burdensome to lower-income individuals.

On the whole, therefore, a tax may not be the most appropriate policy instrument to deal with the information problem. It is true that some estimates of behavioral response suggest that taxes can elicit a large response from teenage smokers (a reduction for the 75-cent tax increase up to a third). But

adolescent smokers account for only six percent of all smokers.[36] Non-tax alternatives may be better targeted. If lack of information about addiction is the primary problem, perhaps a better response is to disseminate information to the young about the dangers of addiction through educational programs in the schools, general advertising, and perhaps through warning labels. If the age of initiating smoking and immaturity of decision-making by young smokers seems to be the primary problem, an approach might be to introduce stricter laws limiting the sale of cigarettes to minors and to enforce those laws.[37] To help current smokers who will constitute the great majority of smokers in the near and medium term, more assistance for quitting (including information and better nicotine replacement devices) may be a desirable public policy.[38] Indeed, one feature that may be desirable in a health care plan is to provide coverage for expenditures on smoking cessation. Finally, a policy option that might help all individuals would be the development of a less dangerous cigarette.[39]

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[36] Calculated from data in National Cancer Institute, *The Impact of Cigarette Excise Taxes on Smoking Among Children and Adults*, Summary Report of a National Cancer Institute Expert Panel, August 1993.

[37] It has been argued that laws barring sales of cigarettes to minors are enforced in only two of the 47 states with such laws. See "U.S. Urged to Escalate Tobacco War," *Washington Post*, January 12, p. A16. See also the discussion in the 1989 Surgeon General's Report, pp. 587-588 and 596-608 regarding smoking policies in public schools, State laws regarding sale and possession by minors, and enforcement issues.

[38] Jeffrey Harris, *Deadly Choices: Coping with Health Risks in Everyday Life*, New York: Harper-Collins Publishers, 1993, suggests that nicotine replacement devices might be improved.

[39] Viscusi (1992) indicates that public health officials have not encouraged such improvements, such as a "smokeless" cigarette that would continue to deliver nicotine and mimic actual smoking without many other adverse effects.

II. CIGARETTE TAXES AS A REVENUE RAISER

The proposed health care program is to be permanent, and the cigarette tax has been presented as a permanent feature of its financing. One standard for evaluating the tax might be whether it will generate revenue sufficient to finance a constant share of the program's costs over time. If it does not, policy discussions of the proposed health care program ought to consider what financing source will replace cigarette tax revenue beyond the budget window.[40]

This section demonstrates that long-run cigarette tax collections, although increasing over time, will be a diminishing share of long-term health care costs. First, the impact of failure to index the proposed per-unit cigarette tax is discussed. While real spending is likely either to grow (if the health care "price index" increases faster than the rate of inflation) or to remain constant (if the health care "price index" rises at the rate of inflation), the real value of every dollar of tax revenue will decline as the price level rises. Second, it is demonstrated that, even were the tax indexed and income growth zero, health care costs will grow at the rate of population growth while revenue will grow at less than the rate of population growth. This discrepancy occurs because the sensitivity of smoking participation rates to price changes will increase over time, which in turn will generate larger reductions in cigarette consumption and tax revenue. The net effect on the Government's budget from reduced cigarette consumption—the possibility that the Government's reduced medical expenses due to smoking will offset its reduced cigarette tax revenue—is discussed. Third, the effect of per capita income growth on health care spending and cigarette tax revenue is discussed. Finally, an estimate is made of the proposed tax's effect on State tax revenue.

INDEXING

To simplify exposition of the consequences of adopting an unindexed cigarette tax, assume that the price level rises at an annual rate of four percent and that health care costs also rise at this rate of inflation (an underestimate given the current rate of increase in medical care prices). The absence of indexing affects cigarette tax revenue in two ways.

Were the cigarette tax indexed such that the tax rate on a pack of cigarettes always generated 75 cents in real 1994 dollars, the tax revenue collected on each pack of cigarettes would purchase the same amount of health care at any point in time, 75 cents worth in 1994 dollars. Why? Because both health care costs

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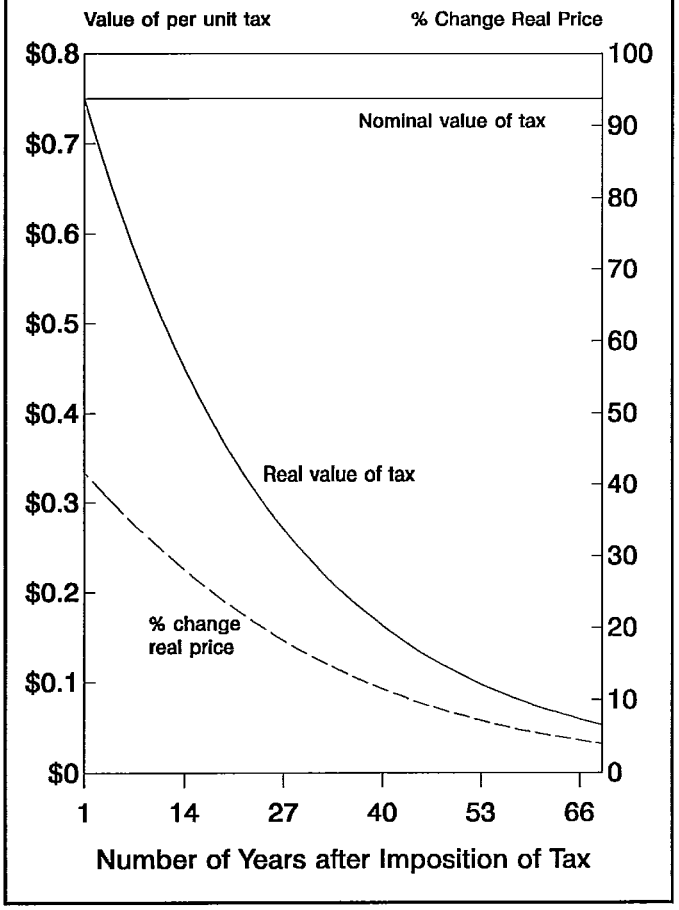
[40] Although some might argue that anticipated long-term administrative cost savings will compensate for the long-term decline in cigarette tax revenue identified in this report, two factors suggest this is far from certain. First, experience shows administrative cost savings to be easy to conceptualize but difficult to achieve. The Reagan budget projections of savings from elimination of "waste, fraud, and abuse" are instructive in this regard. Second, the estimates of long-term cigarette tax revenue decreases in this report do not account for continuance of the long-term downward trend in cigarette consumption, and the decrease therefore is understated.

and revenue would increase at a four percent rate. This is not true for an unindexed tax. After six years, the 75-cent tax on a pack of cigarettes will purchase only 62 cents of health care; after 14 years, 45 cents; after 40 years, 16 cents; and after 53 years, 10 cents. The growing discrepancy between nominal and real tax collections is illustrated by the solid lines in figure 1.

Figure 1. Effect of Four Percent Inflation on $0.75 per Unit Cigarette Tax: Nominal Value, Real Value, and Percentage Change in Real Price



These calculations apply to the tax collected on each pack of cigarettes. The number of packs will be responsive to the price change—the topic of the next section. Any reduction in the quantity smoked will eventually dissipate as the real price effect declines over time. The average pre-tax price of a pack of cigarettes is currently $1.30 ($1.80 minus 24 cents of Federal tax and 26 cents of State/local tax). Assume this pre-tax price of $1.30 is allowed to increase at the rate of inflation and add the 50 cents of existing cigarette taxes to this inflated price. The dashed line in figure 1 is the 75-cent tax divided by this adjusted nominal cigarette price. This percentage change in real price declines from 42 percent today to 28 percent in 14 years, 11.5 percent in 40 years, and 7 percent in 53 years.

SHORT-RUN VERSUS LONG-RUN PARTICIPATION RATE

Even if the tax were to be indexed or if there were zero inflation, cigarette tax revenue would reasonably be expected to finance a decreasing share of health care program cost over time due to behavioral responses of smokers. The response of cigarette consumption to price changes is summarized by estimates of the price elasticity of smoking participation rates and the price elasticity of the quantity of cigarettes smoked per smoker. The participation rate elasticity measures the percentage change in smokers divided by the percentage change

in the price of cigarettes. The quantity elasticity measures the percentage change in quantity of cigarettes purchased per smoker divided by the percentage change in the price of cigarettes.

Two facts are discernible from table 1: the smoking participation rate (column 2) is much more sensitive to price than is the average consumption of smoking participants (column 3); and the smoking participation rate of the young is much more sensitive to price (-1.2 elasticity for 12-17s) than is the participation rate of other age groups (-0.15 elasticity for 36-74s).

Table 1. Price Elasticity of Smoking Participation Rate and Quantity per Smoker, by Age

Age	Participation Rate	Quantity per smoker
12-17	-1.20	-0.25
20-25	-0.74	-0.20
26-35	-0.44	-0.04
36-74	-0.15	-0.15
All ages	-0.31	-0.11

Source: Department of Health and Human Services, *Reducing Health Consequences of Smoking: 25 Years of Smoking, 1989*. Surgeon General Report, Table 13, p.537. These estimates represent a synthesis of numerous econometric studies. See the Surgeon General's report for a summary.

The difference in participation rate elasticity among age groups is consistent with expectations about demand for an addictive or habit-related product. Since one's addiction or habit dependence presumably increases the longer one consumes a product, the ability to quit in response to a price increase is likely to decrease with age.

These elasticity differences have important consequences for long-term revenue collections. The 12-17s' elasticity of -1.2 suggests that a one percent price increase would reduce smoking participation by 1.2 percent. In contrast, the 36-74s' elasticity of -0.15 suggests a one percent price increase would reduce smoking participation by 0.15 percent. As a result, the reduction in smoking participants in response to the 75-cent tax would not be great in the short run—note the weighted price elasticity of participation rates for all ages is -0.31 (53 percent of current smokers in 1992 were 36 or older). Since the 75-cent cigarette tax represents a 42 percent increase in the average $1.80 price of a pack of cigarettes, the number of smokers will decline in the short run by 10.2

percent.[41] When the response of quantity per smoker is incorporated, a reduction in cigarette consumption of 15.1 percent becomes the base for the short-run revenue estimate.

As the years march on, the population of smokers comes to be dominated by new cohorts of 12-17s whose initial smoking participation decision will be made in response to a -1.2 elasticity rather than the -0.15 elasticity. This process will generate a substantial decrease in the long-run aggregate participation rate relative to the rate in effect in the first five or six years of the tax. The expected long-run reduction in consumption of cigarettes will be much greater than in the short run.

As is true with econometric estimation of any behavioral parameter, the precise magnitude of these price elasticities is the subject of considerable debate. The estimates in table 1 are from the "traditional" framework, in which quantity demanded is a function of current price. The long-run price elasticity is inferred from the differences in elasticities by age group, as described above. Recent research has investigated the possibility that an addictive good such as cigarettes is subject to a much more complex demand relationship. This "rational addiction" framework suggests that today's consumption is dependent upon both past and future consumption.[42] This framework estimates short-run and long-run elasticities directly, and finds the long-run elasticity to be higher than the short-run elasticity, a result consistent with this report's use of the elasticities in table 1. The rational addiction estimates, however, tend to find a somewhat smaller difference between the short-run and long-run elasticities than is implied by the estimates in table 1. These smaller differences may be less accurate than the differences from the traditional literature for two reasons: the estimates represent a time period considerably shorter than probably is necessary to capture the full response to price; and the specification of the rational addiction model creates serious econometric estimation problems.

The purpose of the long-run revenue projections presented in this section is to illustrate the existence of a growing revenue shortfall over time. This phenomenon would occur no matter which estimating framework's elasticities are used. Obviously, numerous other factors affecting revenue and not taken into account here would change over the lifetime span of these revenue estimates.

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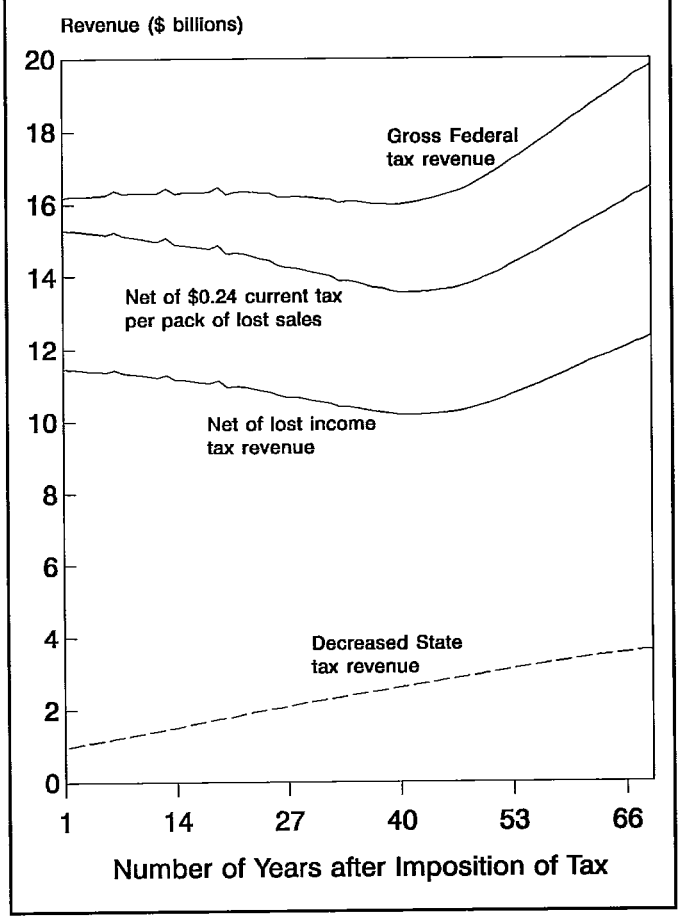
[41] A simple linear calculation suggests a reduction of 13.2 percent, the product of 0.31 and the price change of 0.42, converted into a percentage. A constant elasticity demand function is used in this report, which produces a participation rate reduction equal to $[1 - \{(1.80 + .75)/1.80\}^{-0.31}]$, or 0.102.

[42] See Becker, Gary S., Michael Grossman, and Kevin M. Murphy. *An Empirical Analysis of Cigarette Addiction*. National Bureau of Economic Research Working Paper No. 3322. March 1993; Keeler, Hu, Barnett, and Manning (1993); and Chaloupka (1991).

Federal Revenues

CRS's estimates of gross and net Federal revenue generated by the proposed cigarette tax for the next 69 years are presented in figure 2. These revenue estimates *assume the tax is indexed* and passed forward in a higher price. The estimates incorporate: zero per capita income growth; population growth; and a changing aggregate participation rate elasticity as today's population is aged for 69 years. This allows the entire population (age 12 to 80, an age range that includes almost all smokers) to have its initial smoking participation response to the proposed 75-cent tax be made as a member of the 12-17 age group. The details of these calculations are provided in Appendix C.

Figure 2. Federal and State Revenue from Indexed $0.75 Federal Cigarette Tax: Assumes Population Growth, Increasing Participation Rate Sensitivity, No Per Capita Income Growth

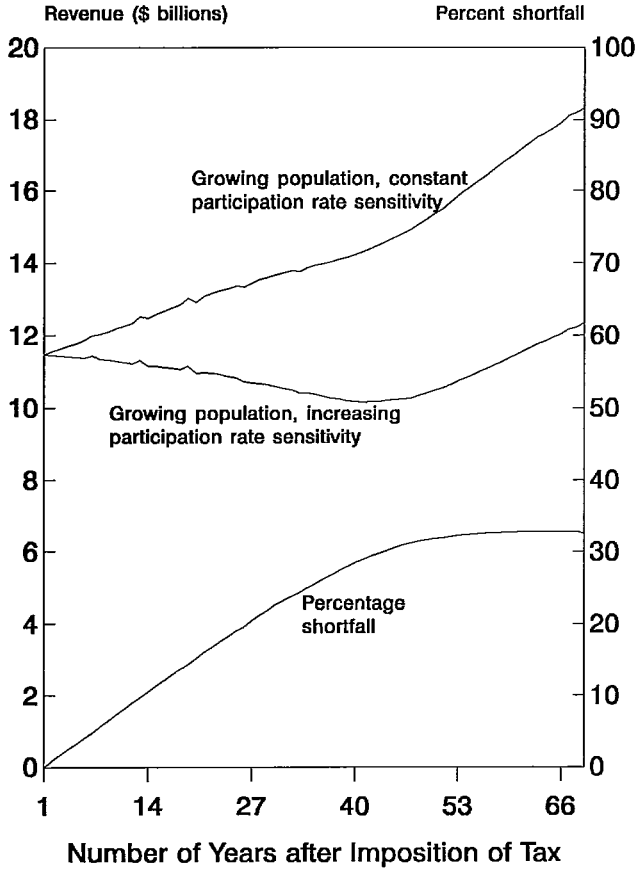


Gross Federal revenue in figure 2 is 75 cents times the number of packs of cigarettes sold. Net Federal revenue reflects two adjustments: a reduction of 24 cents per pack for the existing cigarette tax that is not collected on consumption discouraged by the 75-cent tax (the difference between before-tax and after-tax consumption); and a reduction of 25 cents per dollar of revenue (net of the 24-cent per pack adjustment) for the lost Federal income tax collections attributable to reduced factor incomes (capital and labor income from cigarette sales revenue decreases by the amount of the increased Federal cigarette tax revenue). Net revenue grows over the 69 years from $11.466 billion to $12.353 billion.

The time path of revenue in figure 2 reflects the combined influence of population growth, which increases consumption and revenue, and the population's increasing participation rate sensitivity to the tax-induced price change, which decreases consumption and revenue. The effect of increasing participation rate sensitivity (fewer smokers) on long-term revenue collections

can be isolated in two ways. In figure 3, the upper revenue line is the first year's net cigarette tax revenue ($11.466 billion from figure 2) growing in response to increasing population.[43] No adjustment is made for the increasing participation rate sensitivity—the first year's participation rate sensitivity is assumed to prevail through time. The second revenue line in figure 3 is the same as the lowest solid line in figure 2 that incorporates both population growth and increasing participation rate sensitivity. The difference between the two series is attributable to the changing participation rate sensitivity. As illustrated by the bottom line in figure 3, net tax revenue falls short of the revenue that would be required to finance a constant share of real health care costs (which are assumed to grow at the population growth rate). The shortfall becomes a constant 33 percent of the upper revenue line after 56 years.

Figure 3. Shortfall of Revenue from Indexed Cigarette Tax Due to Increasing Participation Rate Sensitivity: Assumes Population Growth, No Per Capita Income Growth

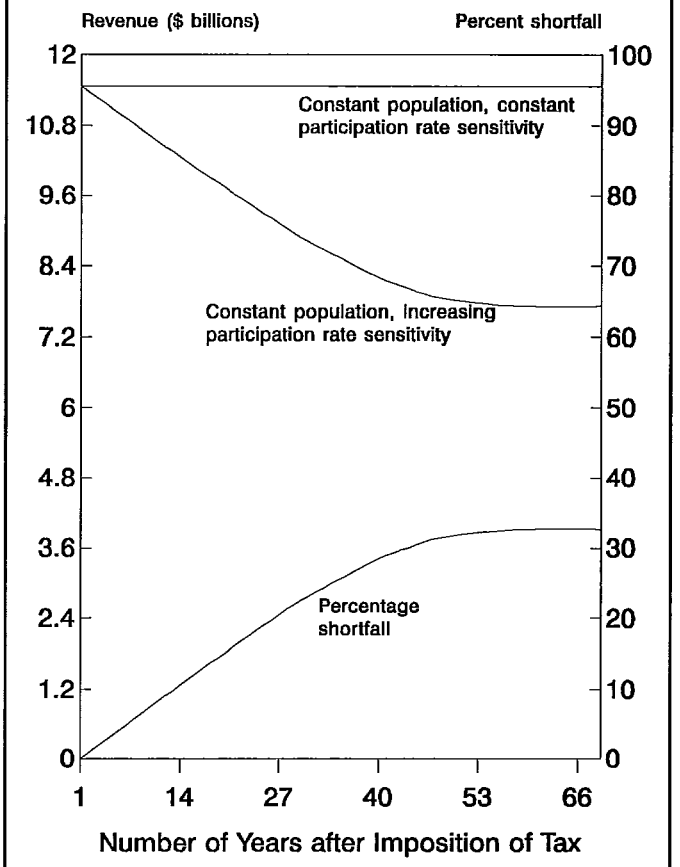


An alternative view of this shortfall is presented in figure 4. Assume that the five-year-budget-window revenue estimate of about $11.4 billion per year will prevail into the future. The resulting horizontal revenue line in figure 4 ignores the influence of both population growth and increasing participation rate sensitivity. The middle line in figure 4 is actual tax collections (lowest solid line in figure 2) "normalized" to remove the effect of population growth, but leaving the influence of increasing participation rate

[43] Figure 2 net revenue in year X is multiplied by the ratio of before-tax consumption in year X to before-tax consumption in year 1. The 505.107 billion cigarettes subject to Federal tax in year 1 grows to 806.670 billion cigarettes in year 69.

sensitivity.[44] In effect, this is the revenue from a tax had it been instituted many years ago; that is, a tax that had been instituted many years ago would provide long-term revenue of $7.7 billion, not $11.4 billion. The difference between the two revenue lines is attributable to increasing participation rate sensitivity. One might say that the shortfall is the amount by which one would overestimate long-run revenue collections if one assumed the budget-window revenue estimate would prevail into the future. Again, the percentage shortfall is 15 percent after 20 years, reaches 30 percent about year 43, and becomes a constant 33 percent of the upper revenue line after year 56.

Figure 4. Shortfall of Revenue from Indexed Cigarette Tax Due to Increasing Participation Rate Sensitivity: Assumes No Population Growth, No Per Capita Income Growth



Net Budgetary Effect

Some may argue that this estimate of a long-run revenue shortfall from an indexed cigarette tax is not an important policy issue because the reduction in smoking will lead to offsetting budgetary savings as the Government's medical expenditures decline.

Several factors suggest that reduced smoking will not improve the Government's budgetary position. First, the preceding section indicates that the net external cost of smoking is less than the tax per pack. For each pack that is not smoked there is a loss of 99 cents (the tax) and a gain of 33 cents (if all external costs are borne by the Government). Thus, the net budgetary effect could be an increase in the deficit of 66 cents.

Second, the 33-cent per pack gain may be received by private sources rather than the Government. In fact, it seems likely that the Federal budget currently

[44] Actual revenue is normalized by multiplying figure 2 revenue in year X by the ratio of before-tax consumption in year 1 to before-tax consumption in year X.

benefits from smoking because of the Government's heavy involvement in Social Security and Medicare, whose costs appear to be reduced due to early death of smokers. In that case, reduced smoking would add to the deficit.[45]

Finally, for purposes of the narrow issue of Government budgetary costs, the appropriate discount rate should be the Government's real borrowing rate, which is typically quite low, perhaps currently in the two percent range.[46] As demonstrated in section I, a discount rate this low generates net external savings from smoking, which means reduced smoking probably would cause an increase in net budgetary costs.

This issue should be explored more carefully. This brief discussion suggests, however, that smoking reductions induced by the proposed tax will generate reductions in Government medical expenditures that are too small to offset the associated reductions in cigarette tax revenue.

INCOME GROWTH

An important determinant of demand for any good or service is income. A "normal good" is one for which consumption tends to increase as income increases. An "inferior good" is one for which consumption decreases as income increases. This relationship is summarized as the income elasticity of a good. A normal good will have an income elasticity greater than zero; an inferior good will have an income elasticity less than zero.

Research on the demand for consumer goods suggests that both health care and cigarette consumption are normal goods for which the income elasticity of demand is more than zero but considerably less than 1.0. At the moment, this literature does not provide strong grounds for suggesting that the demand for cigarettes will grow at a slower rate than will the demand for health care in response to income growth.[47]

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[45] The Government/private shares of medical costs for nonelderly workers might shift under the new system, depending on how binding the percentage caps are. Under the President's proposed health care plan, mandated payments will be limited to a cap as a percentage of earnings. If these caps were binding everywhere, reductions in medical expenditures would result in smaller Government subsidies. If the caps are binding nowhere, there will be no effect. Presumably, the effects will be binding in some cases and not in others.

[46] Based on the WEFA Group forecast for 1992 through 1996 (*U.S. Economic Outlook, January 1994*), the average real rate of interest is less than one percent for 3-month T-bills and slightly over three percent for ten-year bonds.

[47] See Viscusi (1992) for a summary of the cigarette literature. Wasserman, Manning, Newhouse, and Winkler (1991) estimate the income elasticity of cigarette demand at different points in time (1970 through 1985). They find a small negative income elasticity beginning in 1983, which if correct would generate a somewhat larger revenue shortfall than estimated above. For a summary of the medical care literature, see Feldstein, Paul J. *Health Care Economics*. Albany, New York: Delmar Publishers, 1993; and Folland, Sherman, Allen C. Goodman, and Miron Stano, *The Economics of Health & Health Care*, New York: Macmillan Publishing

STATE REVENUE LOSS

As noted earlier, the States levy an average 26-cent tax on a pack of cigarettes. The 75-cent proposed Federal tax will reduce consumption of cigarettes. As a result, States will lose 26 cents on every pack of reduced cigarette consumption.[48] These State revenue losses over time are presented in figure 2 as the dashed line at the bottom of the figure. The State revenue loss grows from $1.0 billion to about $3.6 billion over the 69 year period.

Company, 1993. Feldstein provides a discussion of the estimation issues that plague the income elasticity estimates for health care and leave its "true" value in a state of uncertainty.

[48] After-tax consumption is 85.4 percent of before-tax consumption of 505 billion cigarettes in year 1 of the tax and 65.5 percent of before-tax consumption of 806.7 billion cigarettes in year 69.

III. INDUSTRY EFFECTS OF TOBACCO TAXES

Questions have been raised about the effect on the tobacco industry in general, and its employment in particular, if a tax equal to 42 percent of price is imposed on cigarettes. The issue of job loss from any national policy needs to be discussed from the perspectives of the national economy and the local or regional economy.

JOB LOSS AS A NATIONAL ISSUE

The Tobacco Institute combines its own estimate of reduced demand with Price Waterhouse's estimate of jobs attributable to tobacco to produce an estimate of 273,000 jobs lost from a 75-cent tax.[49]

These job loss estimates are argued to be too high. Studies by the Coalition on Smoking OR Health and Arthur Andersen indicate that almost 90 percent of the jobs attributed to the tobacco industry by the Price Waterhouse study are either indirectly related to the industry (e.g., jobs in retail trade or suppliers to the industry) or are the result of multiplier or expenditure-induced jobs.[50] The expenditure-induced effect accounts for about two-thirds of the job loss, and is based upon an assumption that reduced compensation (factor incomes) in the tobacco industry will in turn reduce demand in other sectors. Other criticisms by these groups of the job loss estimate include: a possible overstatement of effects due to use of a linear demand curve for tobacco; a failure to adjust the estimate for already existing declines in employment and prices; and a failure to consider exports.[51]

In evaluating the jobs issue, first note that the effect of tobacco taxes on total jobs is short-run. In the long run, workers will shift to new jobs; such a tax would not affect the overall long-run unemployment rate.

Even the short-run aggregate job loss estimate is overstated because the assumption of a zero spending offset is not realistic. Money not spent on tobacco by those who quit purchasing it will be spent on other commodities.

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[49] Tobacco Institute, *Economic Impact of the Tobacco Industry and Economic Losses Due to a 75 Cents Per Pack Tax Increase.* 1993; Price Waterhouse, *The Economic Impact of the Tobacco Industry on the United States in 1990.* October 1992.

[50] Coalition on Smoking OR Health, *Tobacco, Health and Jobs: Myths and Realities* (undated); Arthur Andersen Economic Consulting, *Tobacco Industry Employment: A Review of the Price Waterhouse Economic Impact Report and Tobacco Institute Estimates of "Economic Losses from Increasing the Federal Excise Tax",* October 6, 1993.

[51] Some of these criticisms are more valid than others. The elasticities applied by the Tobacco Institute are quite modest, and there is no reason that the tax-induced decline in employment in the tobacco industry will be influenced by any secular trend already occurring. Indeed, such an existing trend would make it less likely that such contractions could be absorbed by attrition. Similarly, the fact that prices have recently fallen has no obvious implication for a tax that is still two years from imposition.

Taxes collected by the Government will be used for other purposes (lower health insurance premiums). While it is true that a tax that reduces the deficit can induce short-run nationwide unemployment, a tax that is offset by an increase in income and spending elsewhere is unlikely to have much effect.[52]

JOB LOSS AS A REGIONAL ISSUE

The jobs issue is a short-run, regional issue. In those areas of the country where tobacco growing and manufacturing are concentrated, job losses would occur. Moreover, a local multiplier effect probably exists, although whether it is as large as that suggested by Price Waterhouse is not clear. The fact that these losses largely will be offset by gains in other areas, however, does not lessen the economic significance of the issue for the affected areas.

On the other hand, if a policy is judged to be beneficial to the Nation as a whole, it ought not necessarily be abandoned simply because it produces subsets of winners and losers. It may be preferable to cushion the blow by simultaneously adopting policies to both compensate losers and smooth their transition. For example, adjustment assistance to affected workers might be offered in the form of payments and training. The remainder of this section estimates the regional job loss for the major tobacco-producing States, to provide some idea of the possible need for, and cost of, transition assistance.

Price Waterhouse estimated an overall nationwide employment of about 160,000 in tobacco growing and auctioning and about 50,000 in manufacturing. About 93 percent of these jobs are concentrated in six states (North Carolina, Kentucky, Virginia, Tennessee, Georgia, and South Carolina), with the lion's share located in the first three.

North Carolina has 40 percent of the growing/auctioning jobs (64,000) and 43 percent of the manufacturing jobs (22,000). Kentucky has 27 percent of growing/auctioning jobs (43,000) and about 14 percent of manufacturing jobs (7,000). Virginia accounts for 7 percent of growing/auctioning jobs (12,000) and a quarter of manufacturing jobs (12,000). The remaining three States are involved mostly in growing and auctioning; each of the three has about 12,000 tobacco-related jobs. Tobacco-related jobs account for slightly under three percent of total State employment in North Carolina and slightly over three percent in Kentucky, but less than one percent in the other States.

If the tax is fully passed on in price and if all production is directed to the domestic market, the expected short-run consumption decrease would generate about a 15 percent reduction in tobacco-related jobs. But all production is not

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[52] Some small effect might result from the time needed for adjustment. These issues are discussed in U.S. Library of Congress. Congressional Research Service. *Is Job Creation A Meaningful Policy Justification?*, Report 92-697 E by Jane G. Gravelle, Donald W. Kiefer, and Dennis Zimmerman, September 8, 1992.

directed to the domestic market, and the job loss estimate must be reduced substantially to reflect the effect of exports, which are not subject to the tax.

Data for 1992 indicate that about 45 percent of flue-cured tobacco production and 32 percent of burley tobacco production are exported as leaf tobacco. In addition, 26 percent of cigarette production (which uses most of the remaining 55 percent of flue-cured leaf tobacco and 68 percent of burley leaf tobacco) is exported. These numbers suggest that exports account for 50 percent of burley tobacco production, 59 percent of flue-cured tobacco production, and 26 percent of cigarette production. Weighting by jobs in manufacturing and growing, and assuming that tobacco in Kentucky is burley and tobacco in the other States is flue-cured, these export effects reduce the estimated tobacco-related job loss by 51 percent in North Carolina, 47 percent in Kentucky, and 38 percent in Virginia. That is, demand for tobacco workers would be expected to fall, after adjusting for export demand, by 7 percent in North Carolina, 8 percent in Kentucky, and 9 percent in Virginia.

The importance of this job loss to each State's economy depends on both the percentage change in tobacco-related employment and tobacco-related employment's share of total employment. Multiplying these percentages indicates that total employment would fall by about three tenths of one percent in Kentucky, about two tenths of one percent in North Carolina, and less than one tenth of one percent in Virginia. Even a large regional multiplier would be unlikely to increase any effects beyond one percent. Of course, these effects are not evenly spread across each State, and would produce larger local effects.

Two factors might reduce the effect on jobs. The first is the possibility that the tax will not be immediately passed on in price. Tobacco manufacturers who are not able to alter instantaneously their capital stock may absorb some of the tax in the short run. Second, consumers may take some time to adjust to the higher prices.

Finally, one of the best forms of transition assistance for a major policy change such as the cigarette tax increase might be to phase it in over a few years. The proposed tax does just the opposite—because it is not indexed, it begins as a large tax that declines in value over time.

IV. THE EQUITY ISSUE

Selective excise taxes often are not considered desirable revenue raisers because they disproportionately burden those who use the taxed products, thereby imposing horizontal inequities (unequal taxation of those with equal income). Excise taxes also may be considered undesirable because they tend to impose a heavier share of the burden on lower-income individuals than does the traditional source of Federal revenue, the income tax.

These equity issues have always been important in evaluating excise taxes on tobacco, and have been discussed comprehensively in a recent Congressional Budget Office study.[53] These equity issues are summarized below.

Cigarette taxes are especially likely to violate horizontal equity and are among the most burdensome taxes on lower-income individuals.[54] Only about a quarter of adults smoke, and less than half of families have expenditures on tobacco. Tobacco is more heavily used by lower-income families than are other commodities, and is unusual in that actual dollars (in addition to the percent of income) spent on tobacco products decline in the highest income quintile. As a result, tobacco taxes impose a burden (as a percent of income) on the lowest fifth of families that is 3.6 times the average burden and 8.0 times the burden on the highest quintile.[55] In contrast, the income tax burden on the lowest quintile is less than one-tenth the average burden.[56] However, these concerns about distribution across incomes may be ameliorated by the benefits of the health care program, which would constitute larger proportion of the income of lower-income individuals.

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[53] Congressional Budget Office, *Federal Taxation of Tobacco, Beverages, and Motor Fuels*, August 1990, Washington, D.C., U.S. Government Printing Office, p. 34.

[54] It is probably appropriate to focus on the amount of the tax imposed in excess of spillover costs, however, in assessing horizontal equity.

[55] Congressional Budget Office (1990), p. 29.

[56] Congressional Budget Office, Effects of Adopting a Value Added Tax, February 1992, Washington, D.C., U.S. Government Printing Office, p. 35.

V. POLICY IMPLICATIONS: ALTERNATIVE FINANCING SOURCES AND OTHER POLICIES

An increased cigarette tax as a method of financing health care reform appears questionable on efficiency, budgetary, and equity grounds. The most straightforward justification for linking the two—that smokers impose financial costs on nonsmokers—probably has already been corrected by existing cigarette excise taxes. The revenue from the tax will be substantial but will decline over time relative to budget-window estimates and will finance an increasingly smaller share of health care costs. The cigarette tax will fall on a small share of the population and will disproportionately burden lower-income individuals compared to almost any other revenue source. On the other hand, the tax does have considerable popular support and would help to deter the young from becoming smokers, although stricter enforcement of restrictions against sales to minors and prohibition of smoking in areas frequented by minors might accomplish the same goal.

If the Congress is interested in exploring alternatives to cigarette tax financing, several are available. First, other taxes that possess more desirable economic effects might be considered to replace all or part of the revenues to be derived from the tobacco tax. Second, some of the spending programs in the health plan might be adjusted or eliminated, thereby making tax increases unnecessary. Third, should all or part of the tobacco tax be retained, design improvements might be considered. Finally, alternative policies to target concerns about teenage smoking are discussed.

OTHER TAX SOURCES

An alternative revenue source that comes to mind in this context is an increase in the excise tax for alcoholic beverages. As with tobacco consumption, a link exists between alcohol consumption and health (both as a result of damage due to drinking and from traffic injuries). Evidence from the Manning study suggests that, unlike tobacco, spillover effects for alcohol substantially exceed current taxes. Thus, substitution of an alcohol tax for the tobacco tax would improve economic efficiency. Alcohol taxes are also regressive, but they are less regressive than tobacco taxes. About $8.0 billion is estimated to be collected from alcohol taxes in FY 1994 (compared to $5.7 billion for tobacco), so that the current taxes would have to be increased by a smaller percentage to yield the same amount of revenue. Taxes are currently lighter on beer and wine, per ounce of alcohol, than they are on distilled spirits.

Another alternative is to increase the rates or broaden the base of the traditional main source of Federal revenue, the income tax. Either rate increases or base broadening would be progressive compared to the regressive tobacco tax, and would fall broadly on all individuals rather than on a narrow group. Thus, the income tax might be considered a more equitable source of revenue for a national health care system. In addition, some base broadening options would seem to be natural for health care reform because they could also

promote economic efficiency in the health care market. A prime example is employer-paid health care premiums, which under current law and under the proposed plan distort consumer choices because they are excluded from the individual's income and are deductible by the employer.

PROGRAM REDUCTIONS

The health care proposal is a very large, complicated plan, and opportunities may exist to reduce spending. In general, tax revenues collected under the plan are dispensed either in benefit increases to public health programs (such as increased drug benefits for Medicare) or in a network of subsidies woven into the plan. One subsidy would prevent mandated employer premiums from exceeding a percentage of salaries; another would help lower-income individuals pay for their share of program costs.

Within this network of subsidies, the set of subsidies for small businesses might deserve particular attention. Under the proposal, small businesses will receive special subsidies for their mandated premiums, with the subsidies based on a sliding scale that moves with business size and wage income. The argument for these subsidies is essentially a transitory one—concern that the imposition of these mandated payments on smaller firms that did not already have such plans will cause unemployment. As a permanent measure, such subsidies are likely to be inefficient—favoring workers of small firms may misallocate resources and generate less economic output. Due to the transitory nature of this problem, these subsidies could be phased out over a few years.[57]

MODIFICATIONS TO A CIGARETTE TAX

If a cigarette tax is to be used owing to its feasibility, short-run revenue generating potential, impact on smoking reduction (particularly among the young), and ease of administration, policy makers are faced with a revenue source that declines in real terms and relative to the program expenditures.

A straightforward revision would be to index the tax. While one can debate the merits of imposing a tax in the first place, if the tax is to be imposed, indexation would ensure that the tax maintains its real value. A tax that is not indexed creates short-term disruption in the industry for a revenue source that eventually will dissipate. In addition, because the erosion in real value due to failure to index occurs slowly, an unindexed tax looks better for budgetary purposes in the short run than in the long run. Of course, indexation could be achieved by periodic revisions on an ad hoc basis, but it is difficult to see the merits of such an ad hoc system as opposed to the certainty of an indexed tax if maintenance of a fixed share of financing through the tax is a policy goal.

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[57] Over a long period, the small business subsidies will eventually disappear because they are tied to average earnings of the firm's employees, which are not indexed.

Even with an indexed cigarette tax, revenues from it will still decline. Unless a similar decline in spending can be identified in the current program, or can be incorporated into the health plan, the shortfall in the tax will lead to an increase in the budget deficit.

POLICIES TO AFFECT SMOKING AMONG THE YOUNG

If the primary focus of the cigarette tax is to decrease youth participation rather than to generate revenue, an alternative and more carefully targeted approach might be increased regulation and information programs. A regulatory approach might target restrictions in areas frequented by teenagers (such as schools and libraries) or might include stricter laws prohibiting the sale of cigarettes to minors. Although research on the effects of regulations has only just begun, it suggests that regulatory policies may be effective in discouraging the initiation of smoking among the young.[58] Indeed, it is possible that price responses actually are smaller than those estimated, and that some of the measured response is reflecting the effect of regulatory policies. Such regulatory policies might be more effective than taxes, as well as more targeted. Such policies would avoid the adverse economic consequences that cigarette taxation imposes on the mature smoking population. Should taxation remain the preferred deterrent even without the revenue goal, greater reductions in smoking would be obtained if the tax was cut loose from the health care program and its revenue earmarked for increased antismoking regulatory and education efforts, perhaps including a system of grants to the States. Such earmarking was a feature of California's 25 cent per-pack tax that was enacted in 1989.[59]

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[58] Wasserman, et al. (1991). included.

[59] National Cancer Institute (1993).

APPENDIX A: EVIDENCE ON PASSIVE SMOKING EFFECTS

The Manning study data do not indicate much of an effect of increased health costs from passive smoking. These data are used to calculate the health care costs of active smoking, but not passive smoking.[60]

The claim that passive smoking results in damage to the health of nonsmokers is based upon both theory and empirical analysis. In this view, the theoretical case for the existence of passive-smoking effects is considered to be sound and leads investigators to expect to find empirical support for the proposition.

This theoretical case that passive smoking imposes external costs on nonsmokers can be summarized in three steps: (1) environmental tobacco smoke has the same components as smoke inhaled by smokers; (2) there is physical evidence of some absorption of these components; and (3) a positive relationship exists between active smoking and additional disease and health costs.

Questions have been raised about this entire chain of reasoning, but the focus here is the third link in the chain. This link is based upon evidence on active smokers who report different amounts of smoking. Even the lightest smokers among active smokers, however, experience far greater exposure to and absorption of disease-causing agents than do passive smokers. Such evidence on active smokers is necessary but not sufficient to conclude that a similar relationship exists for passive smokers. It is entirely plausible that the (unknown) health effects/physical damage function rises very little over the range of exposure levels for passive smokers and begins to rise rapidly as the physical damage levels experienced by active smokers are approached.

The existence of an exposure threshold for disease onset below which many passive smokers fall is not implausible. Most organisms have the capacity to cleanse themselves of some level of contaminants. It is for this reason that public policy usually does not insist that every unit of air or water pollution be removed from the environment; the damage of low levels of pollutants is sufficiently small (through the self-cleansing process) that removal is not cost effective. In fact, strongly nonlinear relationships in which health effects rise with the square of exposure, and more, have been found with respect to active smoking (see Surgeon General's Report, 1989, p. 44). Were these relationships projected backward to construct the lower (unknown) portion of the health effects/physical damage function, the observed relationship might lead researchers *a priori* to expect no empirical relationship. Thus, the issue raised by this potential break in the causative chain is whether researchers should expect to find a significant relationship between passive smoking and health effects.

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[60] The Manning study uses other data to make some calculations on the cost of cancer deaths from passive-smoking. The details of these calculations are unclear and the results appear to be inconsistent with the remainder of the study.

A number of epidemiological studies have assessed the effects of environmental tobacco smoke on specific diseases, with the largest body of research focusing on lung cancer among nonsmoking wives of smokers. There have also been a number of studies on heart disease in spouses of smokers and general respiratory illnesses in children. Based upon these studies, several Government agencies have, in the last few years, taken the position that environmental tobacco smoke causes health hazards, including the Office of the Surgeon General and the Environmental Protection Agency (EPA).[61] These hazards include lung cancer risks in nonsmoking adults and respiratory effects in children. EPA issued a risk assessment in 1992 that classifies environmental tobacco smoke as a cancer-causing agent.

The positions taken on passive smoking's effects on health by Government agencies and by the EPA 1992 assessment in particular have been subject to criticism by the tobacco industry and by some researchers.[62] The following discussion of the lung cancer effect draws on the evidence presented on both sides of the passive smoking issue with regard to the statistical and scientific evidence.[63]

First, critics have questioned how a passive smoking effect can be discerned from a group of 30 studies of which six found a statistically significant (but

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[61] U.S. Department of Health and Human Services, *The Health Consequences of Involuntary Smoking, 1986*, Surgeon General Report, DHHS Publication Number (CDC) 87-8398; and United States Environmental Protection Agency (1992).

[62] A group of tobacco growers and manufacturers has filed a lawsuit challenging the EPA assessment as not being supported by the evidence. Among the issues raised is the use of empirical work based upon exposure in the home to draw inferences about health effects from exposure in the workplace.

[63] These sources include the U.S. Department of Health and Human Services, Surgeon General Reports for 1986 and 1989; United States Environmental Protection Agency (1992), which detail the rationales for their positions. These reports also summarize the epidemiological studies on environmental tobacco smoke, especially on lung cancer and childhood respiratory illness. The reader is also referred to a hearing at which researchers who both supported and criticized the EPA study appeared: U.S. Congress, House Committee on Agriculture Subcommittee on Specialty Crops and Natural Resources, *Review of the U.S. Environmental Protection Agency's Tobacco and Smoke Study*, 103rd Congress, 1st Session, July 1993. For a view that questions the passive-smoking hazard, focusing particularly on lung cancer, and that is written for the layman, see Gary L. Huber, Robert E. Brockie and Vijay Mahajan, "Passive Smoking: How Great a Hazard?" *Consumers' Research*, July 1991, 10-15, 33-34. Huber, et al. also wrote a companion paper on cardiovascular disease "Passive Smoking and Your Heart," *Consumers' Research*, April 1992, pp. 13-19, 33-34. Finally, see Kyle Steenland, "Passive Smoking and the Risk of Heart Disease," *Journal of the American Medical Association*, January 1, 1992, Vol. 267, pp. 94-99. These last two articles provide capsule summaries of epidemiological studies on passive smoking and heart disease. Finally, see The Tobacco Institute, *EPA Report Scientifically Deficient* for a summary of the industry's criticism of the EPA report. Some critics of the claim that passive smoking causes disease have also raised questions about institutional bias in the Government or in the professional journals; those issues are not addressed here.

small) effect, 24 found no statistically significant effect, and six of the 24 found a passive smoking effect opposite to the expected relationship.[64]

EPA attempted to standardize this diverse group of studies to account for statistically important differences in their methodologies. One important difference in the studies is the chance they accepted the absence of a passive-smoking effect when in fact a passive-smoking effect existed. The smaller the size of the sample (number of observations, or people, for whom data was available), the greater the chance of making such a mistake. To correct for these differences, EPA adjusted (weighted) the estimate of passive-smoking effect in each study.[65] This has the effect of reducing the importance of studies with small sample size, studies that would tend to find less significant effects for passive smoking, and increasing the relative importance of studies with large sample size, studies that would tend to find more significant effects for passive smoking.

EPA adjusted the results of each study for misclassification bias (classifying smokers or former smokers as never-smokers). It also made subjective judgments about the extent to which the studies suffered from a variety of other statistical problems, such as confounding (failure to consider the influence of other factors that might increase risk). Those that fared poorly in this analysis were placed in a "Tier 4" category and excluded from the analysis of joint significance of the studies. This procedure allowed EPA to "emphasize those studies thought to provide better data...". (EPA, p. 5-61). After making all these adjustments, EPA combined the studies to conclude that, as a group, the remaining studies indicate existence of a passive-smoking effect.

Another test the EPA conducted was to examine the included studies for evidence of a positive relationship, within each study, between risk and degree of exposure (e.g. number of years smoked). They found such a relationship in 10 of the 14 studies for which such data were available. They also found that the highest-exposure-level group had higher risks than other groups combined, which was statistically significant in 9 of 16 comparisons.

One thing EPA did in its assessment is change the standard for statistical significance from the usual standard, and the one generally used in the original studies. Admittedly, it is unusual to return to a study after the fact, lower the required significance level, and declare its results to be supportive rather than unsupportive of the effect one's theory suggests should be present.

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[64] In this context, if 50 to 100 out of 1,000 active smokers will die of lung cancer, 1 to 2 out of 1,000 passive smokers will die of lung cancer. This is based upon EPA's estimates of lung cancer deaths from passive smoking divided by the total lung cancer deaths attributable to active smoking, plus Viscusi's reported estimates of the lifetime risk of lung cancer deaths from active smoking.

[65] The weight is the reciprocal of the study's passive-smoking effect variance divided by the sum of the weights for all studies, times 100.

However, this characterization masks the critical issue raised by the change in the statistical significance standard. The test of statistical significance used in these studies answers the following question: How large a chance, statistically speaking, are we willing to take that we accept existence of a passive-smoking effect when in fact a passive-smoking effect does not exist? In effect, EPA changed the standard from accepting a chance of two-and-a-half percent to accepting a chance of five percent. The policy implication of this change is that there will be a greater chance of focusing resources on an inappropriate intervention (from an efficiency standpoint).

A few other issues are worthy of mention. These studies do not have (and indeed cannot have) very precise estimates of exposure from environmental tobacco smoke. The data are based on interviews of the subjects or their relatives. If errors in measurement occur in a systematic way that is correlated with development of the disease, the effect would be to bias the results. An example would be if those individuals who developed lung cancer (or relatives of those individuals) remembered or perceived their exposure differently from those who did not develop the disease.

Another concern is the possibility that some nonsmokers are actually current or former smokers and that such current or former smokers are more likely to be married to husbands that smoke. While EPA made some adjustment for this effect, it is not possible to correct precisely for this problem. That is, it remains possible that a relationship observed might reflect the effects of active rather than passive smoking.

In addition, while EPA considered the presence of confounding factors in its evaluation of the studies, this issue is not laid to rest. If wives of smokers share in poor health habits or other factors that could contribute to illness and that are not or cannot be controlled for, statistical associations found between disease and passive smoking could be incidental or misleading. This effect could presumably be correlated with exposure levels.

These limitations of studies are often inevitable, but they impart some degree of uncertainty to the results, especially when relatively small risks are estimated.

Two epidemiology studies that each covered a large number of observations were published in 1992 after the cutoff date for inclusion in the EPA report. The one with the largest number of observations found no overall increased risk of lung cancer among nonsmoking spouses of smokers,[66] the other found an

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[66] Ross C. Brownson, Michael C. R. Alavanja, Edward T. Hock, and Timothy S. Loy, "Passive Smoking and Lung Cancer in Women," *American Journal of Public Health*, November 1992, vol. 82, pp. 1525-1529.

increased, but statistically not significant, lung cancer risk.[67] Both studies looked at exposure levels within their samples and both found a statistically significant increased risk among the highest exposure group in some categories. In smaller exposure groups, the first study found an unexpected relationship (a negative relationship between passive smoking and disease) and the second found a positive, but not a statistically significant, relationship. It has been pointed out that in large studies where the data are broken into several subsets and each is analyzed separately, some associations may be statistically significant as a matter of chance.

Many of the statistical concerns raised above with regard to lung cancer are relevant to respiratory effects in children and heart disease in adults. Indeed, the conclusions by these Government agencies about passive smoking and disease are generally not extended to heart disease. The presence of other factors that may be related to these illnesses that are not controlled for are particularly important in the case of heart disease and general respiratory illness, where the link between active smoking and the disease is not as powerful as in the case of lung cancer. To restate this criticism, if wives or children of smokers share in poor health habits or other factors that could contribute to illness, statistical associations found between disease and passive smoking could be incidental or misleading.[68]

The public health community, at least as represented by these Government agencies, is of the opinion that the weight of the evidence shows that exposure to passive smoke constitutes a small, but real, risk of lung cancer. However, the tobacco industry, some researchers, and some others question that conclusion.

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[67] Heather. G. Stockwell, Allan L. Goldman, Gary H. Lyman, Charles I. Noss, Adam W. Armstrong, Patricia A. Pinkham. Elizabeth C. Candelora, and Marcia R. Brusa, "Environmental Tobacco Smoke and Lung Cancer Risk in Nonsmoking Women," *Journal of the National Cancer Institute*, September 16, 1992, vol. 84, pp. 1417-1422.

[68] Huber, et al., (1992) and Steenland (1992), present a tabular summary of the heart disease and passive smoking literature. The respiratory illness in children and passive smoking literature are surveyed in Environmental Protection Agency (1992).

APPENDIX B: COMPARISON OF ESTIMATING PROCEDURES OF MANNING AND OTHER STUDIES

This appendix explains why the Manning study provides the best estimate of the net external cost of smoking and the size of cigarette tax that is appropriate to compensate for these external costs. Note that the five studies discussed in this appendix control for the influence of age and sex. References to the failure of these studies to control for the influence of nonsmoking factors on external costs refer to factors other than age and sex.

RICE, ET AL.

Several studies attempt to measure the medical expenditures and other health related costs that are caused by smoking. One of the most comprehensive is by Rice, Hodgson, Sinsheimer, Browner, and Kopstein.[69] This study identifies smokers' and nonsmokers' medical expenditures for what are thought to be smoking-related diseases. Smokers' medical expenditures in excess of nonsmokers' medical expenditures are estimated to be six percent of total medical expenditures in 1980.[70] The estimates are not translated into a per-pack cost. Note that this study does not estimate lifetime medical expenditures, includes all excess medical expenditures of smokers (not just the portion paid by society, the external cost share), and does not control for nonsmoking factors known to influence medical expenditures. This study also estimates total lost output due to disability and early death (costs that are largely internal).

OFFICE OF TECHNOLOGY ASSESSMENT (OTA)

The OTA uses the same methodology as Rice et al. to calculate total health costs (external and internal). It finds smokers' excess medical expenditures (for 1990) to be only three percent of total medical expenditures.[71]

The OTA translates these costs (both medical expenditures and lost productivity) into a $2.59 per-pack total cost of smoking in 1990 income levels. This cost greatly exceeds the Manning estimates of spillover effects for several reasons.

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[69] Dorothy P. Rice, Thomas A. Hodgson, Peter Sinsheimer, Warren Browner, and Andrea N. Kopstein, "The Economic Costs of the Health Effects of Smoking, 1984," *Milbank Quarterly*, v. 64, no. 1, 1986, pp. 489-548; they also compare their results to several other studies and find the Rice, et al. results to be slightly higher.

[70] Medical expenditures are taken from House Ways and Means Committee, *1993 Green Book (Overview of Entitlement Programs)*, July 7, 1993, p. 266.

[71] Statement of Roger Herdman, Maria Hewitt, and Mary Laschober, Office of Technology Assessment (0TA), *On Smoking Related Deaths and Financial Costs*, before the Senate Special Committee on Aging, May 6, 1993.

Most importantly, the OTA costs are not limited to and were not intended to measure external effects. There is no offset for the lower pension and Social Security costs of smokers, which would be appropriate to measuring external costs. Almost two thirds of the $2.59 cost results from productivity losses from disability and early death; the majority of these productivity costs are costs to the individual and not spillover costs. The remainder, which amounts to 79 cents, is an estimate of smokers' total excess medical expenditure.

There are other reasons that OTA's costs are larger than the Manning estimates. These appear upon examination of the 79-cent medical expenditures portion of the estimate, which is more readily compared to the Manning estimate. The Manning study's estimate of external medical expenditures amounts to 34 cents in 1990 dollars (adjusted for the medical services price index) for the base case and 20 cents for the estimate that restricts expenditures to those related to smoking-related diseases (cancer, circulatory, respiratory, etc.). Since the OTA study focused on habit-related diseases, it is appropriate to compare OTA's 79-cent figure with Manning's 20-cent figure.

Two adjustments can be made to the OTA 79-cent estimate to make it comparable to the Manning estimate. First, the Manning estimate accounts only for external costs, while the OTA estimate includes both internal and external medical costs. Manning estimated the smoker's out-of-pocket costs (excess internal medical expenditures) to be 28 percent of excess smoker medical expenditures. Using this 28 percent share as a guide to eliminate the internal cost share, the OTA 79-cent estimate is reduced to 57 cents of external costs.

Second, the Manning estimate includes only the portion of these excess costs that remain after adjusting to control for attributes other than smoking that might influence differential health costs. This adjustment reduces costs by about 15 percent. If that same 15 percent reduction were to be applied to the OTA 57-cent estimate, the estimate would fall to 49 cents.

After making these adjustments, the OTA's 49-cent estimate is still 2.5 times the size of Manning's 20-cent estimate. Two additional reasons for these differences are discussed in more detail in the mathematical discussions below, and arise from making lifetime medical expenditure estimates based upon observation of current differences in medical expenditures of smokers and nonsmokers. First, this approach ignores the offsetting medical expenditure savings from smokers' average earlier deaths. Second, it ignores the impact of the time-dependent nature of the relationship between smoking and health care. The health consequences of smoking typically occur many years after smoking has commenced and may appear after smoking has ceased. To calculate the efficient tax, one takes into account the timing of taxes and payments—taxes come earlier. Applying current costs to current cigarette consumption does not

adjust for this effect, as described in the mathematical discussion, and overstates the tax appropriate to cover excess medical expenditures.[72]

Because the OTA estimates do not meet any of the three criteria for estimating external costs—identifying a complete set of *external* savings, controlling for other attributes of smokers besides smoking that might cause medical costs, and using a lifetime perspective—they cannot be used as evidence for the appropriate tax level to account for spillovers.

LIPPIATT

Other studies have examined the costs of lifetime medical expenditures. Some find that lifetime *medical* expenditures are smaller for smokers than for nonsmokers due to earlier death and lower future medical expenditures. One such study is Lippiatt's[73], which relies in turn on Oster, Colditz, and Kelly's estimates of the costs of lung cancer, emphysema and coronary heart disease.[74] The Lippiatt study has been criticized by Hodgson (see next study), who suggests the finding of smaller lifetime medical expenditures for smokers is attributable to using too narrow a definition of smoking-related illness, as well as other limitations.

The Lippiatt study, whether its estimates are right or wrong, uses the same methodology as the Manning study in looking at lifetime external expenditures, but is confined to estimating only the medical expenditure component of external costs. It does not control statistically for other attributes (other than age and sex). Its purpose is to provide a comparison to Manning's estimates of excess lifetime medical expenditures, not to calculate a fully developed spillover effect. This study's finding that smokers have lower lifetime medical expenditures than nonsmokers suggests Manning's net external cost estimate (at least, the estimate when the focus is on smoking-related diseases) may be too high.

The Lippiatt study is an incomplete analysis that cannot be used to measure the total spillover effect, but if its estimates were correct there would likely be significant external *savings* to smoking. Even setting the medical expenditures at zero (no difference between smokers and nonsmokers) would lead to net external savings of 17 cents if there were no adjustment to the effect of smoking on retirement age, and savings of 43 cents if the full adjustment

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[72] Of course, cigarettes smoked over a lifetime may vary individually in their effects on health. Ideally, a tax would reflect the marginal cost of each cigarette, but such an estimate would be difficult to make and such a tax impossible to design.

[73] See Barbara C. Lippiatt, "Measuring Medical Cost and Life Expectancy Impacts of Changes in Cigarette Sales." In *Preventive Medicine*, vol. 19, no. 5, September 1990, pp 515-532. This study focused on the habit-related diseases.

[74] Gerry Oster, Graham A. Colditz, and Nancy L. Kelly. *The Economic Costs of Smoking and Benefits of Quitting*, Lexington, Mass.: D.C. Heath and Company, 1984.

were made. Moving from a net external cost of 33 cents to a net external savings of 17 cents to 43 cents is a shift of 50 to 76 cents per pack.

HODGSON

A recent study by Hodgson finds, like Manning, that lifetime medical expenditures are larger for smokers.[75] The Hodgson study uses the same methodology in measuring lifetime medical expenditures as Manning and Lippiatt. The Hodgson study finds a larger increase in lifetime medical expenditures for smokers than the Manning base case—37 percent for males and 31 percent for females.[76] The Manning study's calculations of per-pack spillover effects reflect an estimated excess of 18 percent.

The Hodgson study does not control for the effect of nonsmoking characteristics. In the Manning study, smoking accounts for about 85 percent of excess medical expenditures. After adjusting for this factor, the Hodgson estimate remains about 60 percent higher than the Manning estimate. Hodgson did not investigate the consequences of restricting the analysis to diseases actually thought to be related to smoking.

As in the case of the Lippiatt study, the Hodgson study does not provide a complete set of estimates that can be used to calculate the external costs per-pack. If all calculations in the Manning study were increased by 60 percent to reflect the higher Hodgson estimate, the total per-pack net external cost would be 53 cents. If only the medical expenditures component were adjusted, the net external cost would be 62 cents. The absolute increases are 20 to 29 cents. These amounts are somewhat higher than the current tax of 50 cents, but would justify only a small increase in tax.

HARRIS

In recent testimony before Congress, Harris estimates that smokers' excess medical expenditures alone add up to $3.71 per pack of cigarettes at 1995 income levels.[77] Comparable estimates from the Manning study are 49 cents

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[75] Thomas A. Hodgson, "Cigarette Smoking and Lifetime Medical Expenditures," *Milbank Quarterly*, Vol. 76, No. 1, 1992, pp. 81-125. This study also reviews other studies. The techniques used by the Hodgson study differ from those in the Manning study in a variety of ways; one which may be a partial source of difference is the use of ten-year age intervals in the Hodgson study.

[76] The Hodgson study uses a base case with a 3 percent discount rate, but reports results at a 5 percent rate as well. For a 3 percent rate, the costs are 32 percent and 24 percent higher respectively.

[77] Testimony of Jeffrey E. Harris. Regarding Financing Provisions of the Administration's Health Security Act, before the Ways and Means Committee, November 18, 1993. Harris also reports $2.32 of costs imposed on nonsmokers by smokers when he adjusts for the fact that smokers share in the higher insurance premiums paid by everyone. This adjustment is not made

for the base case and 28 cents for the lower-bound case based upon habit-related illnesses.

This $3.71 figure relies on an estimate that smokers' lifetime medical expenditures exceed nonsmokers' costs by 20 percent, a difference only slightly greater than the 18 percent difference Manning uses in the base case estimate. So what accounts for the gap between Harris' per-pack excess medical expenditure estimate of $3.71 and the comparable Manning estimate of 49 cents?

Harris' figure is not adjusted for the share of these excess medical expenditures paid for by the smoker (internal costs). If the $3.71 is reduced by the 28 percent internal cost share of the Manning study, it declines to $2.67, or 5.5 times as large. (This adjustment may be too large, but the objective of this exercise is to try to reconcile the two numbers). If the $2.67 figure is adjusted for the slight difference in the two estimates of smokers' excess lifetime medical expenditures (20 percent for Harris and 18 percent for Manning), it declines further to $2.36.

The remaining difference between these estimates is attributable to the upward bias that arises when the 20 percent estimate of excess lifetime medical expenditures is converted into dollar terms by using current medical expenditures and current cigarette consumption rather than using discounted lifetime values. The mathematical exposition below explains that this procedure incorrectly incorporates lifetime medical expenditures into the analysis and causes a substantial overestimate of external excess medical expenditures. This overstatement is particularly likely when smoking has been declining and is probably magnified by the projection forward to 1995.

CONCLUSION

Although some of the other research discussed appears to produce different results from the Manning study, none of these studies correctly estimates the net external costs or savings translated into a per pack equivalent tax. Indeed, the lifetime medical care studies provide some reassurance that the Manning results are reasonable. The Manning study's estimate falls between the two estimates reported here.

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in the Manning study; nor would it be appropriate to do so for measuring the efficient tax. The Manning study attempts to estimate the tax that will correctly price cigarettes to smokers—that is, the costs imposed by the individual smoker on others that are not taken into account by the smoker. If smoking raises insurance costs for everyone, the individual smoker would pay only a tiny fraction of the cost he is imposing since that additional cost is spread over all the individuals in the pool.

MATHEMATICAL COMPARISON OF MANNING, OTA, AND HARRIS ESTIMATES OF PER-PACK COSTS

This section places the Manning estimating procedure in mathematical terms and uses it as a framework for illustrating why the net external costs (and optimal tax) estimated by the OTA and Harris studies are too large.

To illustrate how the Manning per pack calculations are made and how they relate to other calculations, assume a simple model where individuals live for three periods, incurring medical costs in each period. All smoking (designated as one unit of tobacco in period one) occurs in periods one and two, with half as much smoked in the second period (to represent those who quit after the first period). The smoker (whether or not he quits) lives only two periods. Note that the model is not designed to represent smoking behavior, but rather to explain the fundamental differences in the types of calculations.

The present value of health costs for non-smokers is:

$$(1)\quad PVHC_n = C_0 + C_1/(1+R) + C_2/(1+R)^2$$

C represents health costs in each of the three periods, subscripted by 0, 1, and 2. R is the discount rate. Suppose the smoker incurs an additional cost of C_x in the second period. The present value of health costs for the smoker is:

$$(2)\quad PVHC_s = C_0 + (C_1+C_x)/(1+R)$$

The present value of excess lifetime costs of health care for smokers relative to nonsmokers is the difference between (2) and (1), or:

$$(3)\quad PVHC_d = C_x/(1+R) - C_2/(1+R)^2$$

The correct tax will be a tax that sums in present value to these excess costs. If the tax is T per unit, the present value of the tax collected will be (remember, there is one unit of smoking in the first period and .5 units in the second period):

$$(4)\quad PVT = T + .5T/(1+R)$$

To determine the tax, set (3) equal to (4) and solve for T:

$$(5)\quad T = \{C_x/(1+R) - C_2/(1+R)^2\}/\{1 + .5/(1+R)\}$$

Equations (1) through (5) illustrate the Manning study's calculation of excess smoker medical costs. The optimal tax per pack is then calculated by deleting those excess medical costs paid directly by the smoker (internal costs) and adding the smoker's non-medical external costs.

Neither the OTA nor the Harris estimates used this approach.

OTA Estimates

The OTA estimate of tax per pack attributed to medical care is based not on observing the present value of cost differentials, but rather on the amount of smoking-related health costs observed in the economy at any given time. These total health costs that one observes in the economy at a given time can be expressed as the sum of the costs of all the smokers and nonsmokers of different ages in the economy:

$$(6)\quad TC = F\{C_0 + (C_1+C_x)/(1+G_s)\} + (1\text{-}F)\{C_0 + C_1/(1+G_n) + C_2/(1+G_n)^2)\}$$

G refers to the growth rate (of smokers and non-smokers respectively), and F is the share of the youngest group that smokes. The growth rates are necessary to add up the population (and associated costs) of smokers and non-smokers of different ages. Thus, if smokers are growing at growth rate G_s, there will be $1/(1+G_s)$ smokers one period older than the youngest cohort.

The OTA estimates of health costs result from an observation of the additional medical costs of smokers in period 2. The base of the tax will be the actual units consumed (not the present value). The calculated tax will be:

$$(7)\quad T = \{C_x/(1+G_s\}/\{1 +.5/(1+G_s)\}$$

Comparing (7) to (5), one can see that this method overstates the tax for two reasons. First, there is no accounting for the offsetting savings from early death (the second term in the numerator of equation (5)). Second, the second-period costs are discounted at the smoker growth rate rather than the discount rate. Two conditions have to occur for this use of the growth rate rather than the discount rate to overstate the tax. The discount rate must be greater than the growth rate. And the consumption of tobacco must occur earlier than the occurrence of the medical costs. Note that since smoking has been declining, the growth rate will actually be negative. It appears that both conditions for overstatement are satisfied.

Harris Estimates

Now consider the effects of the method used by Harris. Harris begins with an estimate taken from other studies of the percentage increase in lifetime health costs due to smoking, using a ratio slightly higher than Manning's base case estimate. In this example, this excess health cost is:

$$(8)\quad \{C_x/(1+R) - C_2/(1+R)^2\}/\{C_0 + C_1/(1+R) + C_2/(1+R)^2\}$$

Harris converts this number into a per-pack tax, by using observations of shares of the population that are smokers (current and former) and nonsmokers, observations of current consumption, and observations of current medical costs. As is shown below, this procedure can result in significant errors in measurement of the tax.

As a first step, Harris converts the ratio in (8) into a total share of medical costs by the formula $F'r/(1+F'r)$, where r is the ratio in (8) and F' is the observed share of smokers (and former smokers). This share is multiplied by total observed medical costs and applied to observed consumption. After some rearrangement, one finds this tax is equal to the correct tax (in equation (5)), multiplied by three factors.

The first factor is the ratio of F' (the observed share of smokers) to F (the share of the youngest group that smokes). This number will tend to be larger than one (F' greater than F) if the growth of smoking cohorts is smaller than the growth of non-smoking cohorts. In that case, the share of the population that is composed of current and former smokers is greater than the share of the youngest generation that smokes. Since smoking has been declining for many years, this value is likely to be greater than one. (There is some offset for smokers who die earlier than nonsmokers, which reduces the observed population share, but this effect is likely to be quite small, as it affects only a few cohorts.)

The second factor is the ratio of the observed to the present value of medical costs, but with the present value of the smoker's and non-smoker's costs weighted by F' rather than F:

(9)
$$\frac{\{C_0 + C_1/(1+G) + FC_x/(1+G_s)) + (1-F)(C_2/(1+G_n)^2)\}}{\{C_0 + C_1/(1+R) + F'(C_x/(1+R)) + (1-F')(C_2/(1+R)^2)\}}$$

where G represents the overall growth rate of the population (a weighted value of G_s and G_n from the previous period. This ratio will also be greater than one because growth rates are lower than discount rates.

Finally, it will be multiplied by the ratio of the present value of the units of tobacco consumed to the observed value:

(10) $\{1 + .5/(1+R)\}/\{1 + .5/(1+G_s)\}$

This ratio will be less than one because the growth rate, G_s, is smaller than the discount rate.

Theoretically, the product of these three ratios is ambiguous, but when tobacco usage precedes the appearance of most illness by a large stretch of time, the second factor will greatly outweigh the third in importance and a large overstatement of the tax will result. Since tobacco use typically begins in the teenage years and many individuals subsequently quit, but tobacco-related illnesses tend to occur in middle and old age, much more discounting is involved in (9) than in (10). As a result, the discounting that takes place in the ratio of observed to present value medical costs is greater than in the ratio of observed to present value of units of tobacco consumed.

With a significant difference in discount rates and growth rates and a large difference in discounting periods, the calculated tax could be several times the actual tax. Suppose that we ignore the effect of F′/F and any differences between growth rates of smokers and non-smokers. Assume the growth rate is one percent and the discount rate is 5 percent. If medical costs are discounted on average for 40 years, but consumption for ten years, the tax calculated in this fashion will be three times too big. If medical costs are discounted over 50 years, the tax will be five times too big.

APPENDIX C: ESTIMATING PROCEDURE FOR REVENUE PROJECTIONS

Every age between 12 and 80 is assigned the participation rate, average consumption, participation-rate elasticity, and average-consumption elasticity appropriate to its age group.[78] The participation rate and average consumption are combined with population-by-age data to provide an estimate of total cigarette consumption for 1992. This total consumption proved to be about 90 percent of the 504.314 billion U.S. cigarette consumption reported for 1992. Each age group's average consumption is then adjusted upward to ensure that beginning consumption is approximately equal to 1992 cigarette consumption.

Per capita U.S. cigarette consumption has declined steadily from 2,821 in 1979 to 2,009 in 1992. The model estimated here does not attempt to adjust the average cigarette consumption of smokers for this downward trend (although the downward trend in per-smoker consumption would be less significant than the downward trend in per capita consumption due to the downward trend in participation). The output of the model is pre-tax and after-tax consumption for a period of 69 years, a period of time sufficient to allow the entire population to have responded to the tax as teenagers.

Understanding this model requires explanation of two calculations: the size of the population at any point for a given age; and the after-tax participation rate and average consumption for a given age group as it moves in time toward 80 years of age.

SIZE OF POPULATION BY AGE

Data on mortality rates for 1991 indicate that deaths per 100,000 population increase steadily as age increases, from 25.8 for ages 10-14 to 4,806.8 for ages 75-79.[79] This pattern is assumed to remain invariant for the next 69 years. The population in place today at any given age is assumed to die at these mortality rates. Thus, next year's 46s are equal to today's 45s minus the number who die during the year they are 45. The resulting population of 46s in year two (45 year old survivors) in turn dies at the mortality rate of 46s,

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[78] Participation rate and average consumption data are from several publications of the U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Center for Health Statistics: *Advance Data*. No. 221, December 2, 1992, Table 2; *Health United States 1992 and Healthy People 2000 Review*. DHHS Pub. No. (PHS) 93-1232, Tables 64 and 66; and *Vital and Health Statistics, Smoking and Other Tobacco Use: United States, 1987*. DHHS Pub. No. (PHS) 89-1597, Table 1. The elasticity estimates come from the Surgeon General's report cited in table 1 of the text.

[79] U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Center for Health Statistics. *Monthly Vital Statistics Report*. Vol. 42, No. 2, Supplement, August 31, 1993.

thereby generating the number of 47s in year three (46 year old survivors who were 45 when the tax was imposed). This process continues until the original 45s are 80, at which time it is assumed (in order to reduce the computational burden) that all age 80s die (nobody survives to 81). This process allows for no immigration or emigration.

The total population grows at the Census Bureau's 60-year annual growth rate projection (1990 to 2050, middle-series projection) of 0.72 percent. The number of new 12s in year two is equal to the projected new population minus all the survivors for the original 12s through 79s.[80] The number of new 12s in year three is equal to the projected population minus all the survivors for the 12s through 79s in year two. Continuing this process through the years, the number of new 12s in year 69 is equal to the projected population minus all the survivors for the 12s through 79s in year 68.

PARTICIPATION RATES AND AVERAGE CONSUMPTION

The population in each age group is assumed to respond to the implicit price increase imposed by the $0.75 tax at the participation-rate and average-consumption elasticities presented in table 1 on page 23. All pre-tax smokers are assumed to respond to the tax only at the time it is imposed. But participation-rate data indicate that an age cohort's participation rate (prior to the 75-cent tax) increases through age 44 and then begins to decrease. Thus, some nonsmokers below age 45 at the time the tax is imposed will begin smoking at a later date, and some smokers older than 45 at the time the tax is imposed will stop smoking at a later date.

How do these nonsmokers at the time the tax is imposed respond to the 75 cent tax when they begin smoking at a later date (an older age)? As long as the participation-rate elasticity for the age group the new smokers were in at the time the tax was imposed is identical to the participation-rate elasticity for their new (older) age group, the new smokers are subject to the same response to the tax price increase as the original smokers in the cohort. But when the participation-rate elasticity has decreased (see table 1), potential new smoking participants (the difference between a higher participation rate and the previous lower participation rate) are assumed to respond to the lower elasticity. At that point, the after-tax participation rate for the age cohort is a weighted average of original participants responding at the original, higher participation-rate elasticity and new participants responding at the new, lower participation-rate elasticity.

Another strategy is called for when a cohort's participation rate decreases. The weighted after-tax participation rate calculated for the cohort at a younger age is reduced by the percentage reduction in the participation rate, thus

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[80] In year two, total population is equal to the original population times $(1+.0072)^1$; in year three, the multiplication factor is $(1+.0072)^2$; and in year 69, the factor is $(1+.0072)^{68}$.

assuming smoking dropouts are spread proportionately over original and new smokers.

Average consumption of a cohort's smokers also changes over time. It is assumed that all smokers in an aging cohort, whether they be original or new smokers, consume cigarettes at the historical record of average consumption for their current (post-tax) age, adjusted for the price elasticity of average consumption for their current (post-tax) age. That is, if at the time the tax is adopted after-tax consumption for a 45-year-old is X and for a 60-year-old is Y, today's 45s will consume Y at age 60 (whether new or old smokers) and today's 12s will consume X at age 45.