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Improving the Fire Safety of Cigarettes: An Economic Impact Analysis

Technical
Study Group
Cigarette Safety
Act of 1984

October 1987

ROSALIE T. RUEGG
STEPHEN F. WEBER
BARBARA C. LIPPIATT
SIEGLINDE K. FULLER

Center for
Applied Mathematics
National Bureau
of Standards

Mission and Members

The Technical Study Group on Cigarette and Little Cigar Fire Safety was established by Public Law 98-567, the Cigarette Safety Act of 1984, on October 30, 1984. Its mission is to:

"undertake such studies and other activities as it considers necessary and appropriate to determine the technical and commercial feasibility, economic impact, and other consequences of developing cigarettes and little cigars that will have a minimum propensity to ignite upholstered furniture or mattresses. Such activities include identification of the different physical characteristics of cigarettes and little cigars which have an impact on the ignition of upholstered furniture and mattresses, an analysis of the feasibility of altering any pertinent characteristics to reduce ignition propensity, and an analysis of the possible costs and benefits, both to the industry and the public, associated with any such product modification."

Copies of this or any other reports of the Technical Study Group may be obtained from Mr. Colin B. Church, Secretariat, Technical Study Group, Consumer Product Safety Commission, 5401 Westbard Avenue, Washington, D.C., 20207.

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Max Hausermann, Ph.D.

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Executive Summary

In response to requirements of the Cigarette Safety Act of 1984, this report investigates potential economic impacts of modifying cigarettes to reduce their ignition propensity. It identifies impacts which appear likely to result from altering major physical characteristics of cigarettes: tobacco blend, paper, and size. It develops a quantitative model for estimating first- and second-order impacts. First-order impacts are changes in smoking-related fire losses, including estimates of the change in lives (and life years) lost, injuries incurred, and property damage. Second-order impacts are changes which may result if modifying the ignition propensity of cigarettes inadvertently modifies other cigarette attributes. The following second-order impacts are estimated by the model: cigarette industry impacts, including changes in the price of cigarettes, cigarette sales volume, and industry revenue; tobacco farming impacts, including changes in the price of tobacco, tobacco sales volume, and farm revenue; smoking related health impacts, including changes in lifetime medical costs and life expectancies; consumer surplus impacts; employment impacts; and excise tax revenue impacts. A number of case analyses are performed, quantitative results are presented, and implications of the findings are discussed.

Because this assessment precedes any action to alter the ignition propensity of cigarettes in the marketplace, it must be predicated upon a number of assumptions. The need to make assumptions—such as assumptions about how cigarettes might be modified physically to reduce their ignition propensity, the extent of and time required for the changeover, and the reaction of manufacturers and consumers to an altered product—was a recognized condition and limitation of the study, and one that should be kept in mind in reading the report.

To help meet the extensive data requirements for performing quantitative impact assessment, the Technical Study Group (TSG), commissioned by Congress to implement research requirements of the Cigarette Safety Act, engaged under separate contract seven consultants, experts in their respective six fields. The TSG made available to the authors the data and reports developed by these contractors. (See Reports 5 and 6, Technical Study Group.) The accuracy of these data has not been verified by the National Bureau of Standards.

Given the necessity to make a number of assumptions and to use data to which varying levels of confidence can be attached, the findings are subject to uncertainties. To reflect these uncertainties, case analyses based on alternative assumptions are shown, as well as the results of extensive sensitivity testing.

These caveats notwithstanding, the following major points can be drawn from the analyses:

- If cigarettes were to be made completely fire safe, each year about 1500 people fewer would die in fires, roughly 7000 fewer people would be injured in fires, and nearly half a billion dollars in property losses would be avoided. To the extent that the fire hazard of cigarettes is not completely eliminated by reducing their ignition propensity, savings will be proportionately lower.
- The savings potential from fire-safe cigarettes is estimated to decline gradually over time, but is likely to remain relatively strong over at least the next 10 years. A projected downward trend in cigarette consumption, an increase in the prevalence of fire-resistant bedding and upholstery, and improvements in fire mitigation technologies are estimated to diminish deaths and injuries from cigarette fires by 20 to 25 percent and property losses, by about 10 percent by the mid-1990's.
- If, in the process of modifying cigarettes to change their ignition propensity, other attributes were to be changed, impacts beyond the intended reduction of cigarette-fire losses will likely result.
  - A change in the mix or quantities of raw materials, labor, and/or production processes for manufacturing cigarettes would change the relative demand for the factors of production used in cigarette production.
  - A change in the cost of producing cigarettes could affect their pricing and therefore their consumption.
  - A change in smoking attributes, such as taste, appearance, handling characteristics, and potency could affect consumer demand and therefore cigarette consumption.
  - A change in chemical potency could directly affect the health consequences of smoking by changing the delivery of tar, nicotine, carbon monoxide, and other chemicals in cigarettes.
- Five hypothetical methods of modifying cigarettes (listed in the first column of the summary table on page xiii) are used in this study to facilitate model development, to allow identification of the types of potential impacts, and to test

the order of magnitude of impacts which might result from representative modifications to cigarettes.

- The five modifications are estimated to cause only small percentage changes in the supply price of cigarettes. Two of them are estimated to entail a small reduction in the cost of producing cigarettes; two, a small increase in production costs; and, one, to be approximately neutral in its cost consequences.
- Several of the modifications are estimated to have a significant direct effect on the raw materials, labor, and production processes for manufacturing cigarettes. Two of the modifications are estimated to require substantially less tobacco, but one of these is estimated to require more expandable tobacco than existing cigarettes. One of the modifications is estimated to require increased use of expansion processing. One is estimated to require a chemical additive. One is estimated to require considerably more paper. And all are estimated to require machinery adjustments and/or machinery and equipment replacements, possible downtime and lost production, and process changes.
- The effects of the five hypothetical modifications on consumer demand and on health from possible changes in cigarette potency are unknown, and are treated in the study only in the context of sensitivity analysis. Potentially, consumer demand and direct health effects could be important. The impact model is capable of taking these effects into account, if reliable data are available.
- For each of the five modifications, the table on page xiii summarizes analysis results, based on assumptions listed at the bottom of the table. Principal observations to note from the table are the following:
  - Identical estimates of first-order impacts (based on the assumption of 75 percent reductions in cigarette-fire losses) are shown for each modification in lieu of laboratory-based performance data. As performance results become available, these first-order impacts should be adjusted accordingly.
  - Cigarette production cost changes in the range of −3% to +2% drive the second-order impacts shown in the table. Changes in cigarette potency are ignored, as well as non-price changes, such as taste, which may influence the demand for cigarettes.

    Decreased circumference is estimated to lower production costs by about 3 percent, principally through lower tobacco content in cigarettes. The resulting impacts are estimated to be a 15 percent reduction in annual revenue from tobacco farming, a 3 percent reduction in annual cigarette industry revenue, a 1 percent increase in annual federal excise tax revenue, a one percent increase in lifetime smoking-related health costs, a 4 percent reduction in full-time equivalent tobacco-industry jobs, and an annual increase in consumer satisfaction (due to the estimated lower price) of $660 million.
  - Reducing the tobacco density in the cigarette is estimated to lower production costs by about 1 percent, as lower tobacco requirements are estimated to more than offset higher processing costs. The resulting impacts are estimated to be a 6 percent reduction in annual farm revenue; a 1 percent or less reduction in annual cigarette industry revenue, annual federal excise tax revenue, and full-time equivalent employment; a less than 1 percent increase in lifetime smoking-related health costs; and a $290 million annual increase in consumer satisfaction.
  - Adding a chemical to the blend to cause self-extinguishment is estimated to increase production costs by about 2 percent. (This, of course, would vary depending on the chemical selected for study.) The resulting impacts are reductions of 1 percent or less in annual farm income, annual federal excise tax revenue, lifetime health costs, and full-time equivalent jobs; a 2 percent increase in cigarette industry revenue; and an annual loss in consumer surplus of $380 million.
  - Changing the paper, either by increasing weight or by decreasing porosity, is estimated to have little impact in the second-order impact categories shown, because paper constitutes a very small percentage of the total cost of a cigarette. However, increasing the paper weight would be expected to have impact on the paper industry, an industry impact outside the scope of the study.
  - When second-order impacts are limited to those driven by changes in production costs (potency changes and possible shifts in consumer demand are ignored), the modification having the largest estimated second-order impacts is decreasing cigarette circumference (15% reduction in tobacco farm revenue and 4% reduction in tobacco-industry employment); and the modification with the smallest impact is decreasing paper porosity (no impact within the categories included).
  - Changes in lifetime smoking-related health costs estimated to result from decreasing the production cost of cigarettes are no more than 1 percent of the base. But, because the estimated base is very large, a one percent change translates into about $600 million in lifetime medical costs and 300 thousand life years (present value dollars and years discounted at 5%). [For perspective, a 75% reduction in cigarette fire deaths is estimated to save about one-half this number of life years over a 10-year period.]
  - The small percentage changes in cigarette supply prices are estimated to cause relatively small second-order impacts in terms of percentage changes in base numbers; in absolute terms, however, some impacts appear large.
- Not shown in the table are possible impacts resulting from changes in cigarette potency attributable to cigarette design modifications. Potency changes may change health risk exposure. Because changes in exposure apply to *all* modified cigarettes (not just to the change in consumption), changes in potency have large potential health impacts. Increases in potency may increase health costs; decreases in potency may decrease health costs. Inadequate data on the relationship between changes in the chemical composition of cigarettes and health risk exposure prevented quantitative estimation of this impact, beyond sensitivity testing. The model, however, has the capability of treating potency changes if data become available.
- Also not shown in the table are impacts estimated to result from shifts in the level of consumer demand due to

changes in taste, handling characteristics, and other factors related to consumer demand. There is little basis for specifying shifts in demand for these modifications, though sensitivity analysis can be used to demonstrate the effect of hypothetical demand changes. Decreasing demand can be expected to have negative impacts on the farm sector, the cigarette industry, excise taxes, and employment, and positive impacts on health; increasing demand, the opposite impacts. For example, if lowering the tobacco content (by decreasing circumference or tobacco density) were to cause a small decrease in demand for cigarettes, the reduced demand would offset to some extent several of the second-order impacts shown in the table for these two modifications, namely the increased health costs and the increased consumer surplus, and would amplify other second-order impacts, namely, the decreased farm revenue, cigarette revenue, and employment.

- Certain impacts are likely to be highly concentrated regionally: primarily farming and cigarette manufacturing impacts and tobacco-industry employment impacts.

It is important to note that the modifications included in the study are not necessarily the best approaches for improving the fire safety of cigarettes. They were designated for use in the economic analysis by the Technical Study Group in order to cover principal physical characteristics of cigarettes which can be altered. Structuring the model to handle these modifications required that versatility be built into the model, making it capable of treating changes in any major cigarette component. Other cigarette modifications which may be proposed at a later time can be evaluated with the economic impact model, if specific cost data are provided in the required format.

It is also important to place the findings of the study in proper perspective. The purpose here is to assess the impacts that might arise from making fire-safe cigarettes, not to advocate the pursuit of impacts other than the objective of fire safety. Other objectives should be judged on their own merits. Understanding the secondary, as well as the primary, consequences of actions is essential for sound policy development. To the extent that undesired second-order impacts arise, it may be possible by tax policy, by statute, or by technological innovation to neutralize them, such that the benefits of fire safety are not eclipsed by other impacts.

Estimated Impacts of Five Cigarette Design Modifications: Summary Comparison

	First-Order Impacts			Second-Order Impacts										
	Cigarette Fire-Loss Reductions in Year 1 (Based on Uniform 75% Reduction			Change in Tobacco Farming Revenue in Year 1		Change in Cigarette Industry Revenue in Year 1		Change in Fed.Excise Tax Revenue in Year 1		Change in Consumer Surplus in Year 1	Change in Lifetime-Smoking-Related Health Costs			Change in Full-time Equivalent Jobs in Tobacco-Related Industries in Year 1	
												Medical Costs	Expected Life-Yrs.		
Modification	Lives Saved	Injuries Avoided	Property Loss Avoided mill.$	%	mill.$	%	mill.$	%	mill.$	mill.$	%	mill.$	(1000)	%	Jobs
Decreased Circumference	1200	5600	350	-15	-330	-3	-500	1	50	660	1	570	-260	-4	-6200
Decreased Tobacco Density	1200	5600	350	-6	-140	-1	-210	0	20	290	0	250	-110	-1	-1400
Chemical Additive to Blend	1200	5600	350	0	-10	2	290	-1	-30	-380	0	-300	170	0	-500
Increased Paper Weight	1200	5600	350	0	0	0	70	0	0	-90	0	-70	40	0	400
Decreased Paper Porosity	1200	5600	350	0	0	0	0	0	0	0	0	0	0	0	0

ASSUMPTIONS:
- Uniform 75% reduction in smoking-related fire losses to be achieved by each modification.
- Supply price fully reflects changes in production costs.
- Percentages rounded to nearest integer; millions of dollars rounded to nearest 10 million; numbers of lives, injuries, and jobs rounded to nearest hundred; life-years rounded to nearest thousand. Percentages in the range -0.04 to +0.04 are shown as zeros.
- Quantity of cigarettes demanded is affected only by price.
- Changes in cigarette potency are ignored.
- Immediate implementation
- Percent changes in cigarette production costs: decreased circumference -3%; decreased density -1%; chemical additive +2%; increased paper weight +1%; decreased paper porosity 0%.

1. Introduction

1.1 Background

The Cigarette Safety Act of 1984 (Public Law 98-567; Stat. 2925, October 30, 1984) created the Technical Study Group (TSG) on Cigarette and Little Cigar Fire Safety to investigate the technical and commercial feasibility, economic impact, and other consequences of developing cigarettes and little cigars with "minimum propensity" to ignite upholstered furniture and mattresses. The TSG requested that the Applied Economics Group (AEG) of the National Bureau of Standards (NBS) perform the economic impact analysis, and arranged for the study to be done under an Interagency Agreement between NBS and the Consumer Product Safety Commission (CPSC) (IAG-74-25, Task Order No. 86-2 (86-1198)). The agreement called for an analysis of economic impacts to be performed and a report of findings to be prepared by the AEG for the TSG in a written form suitable for inclusion by the TSG in its final reporting to Congress. This is the report on the economic impacts.

1.2 Purpose and Organization

The purpose of this report is to: (1) identify potential economic impacts from reducing the ignition propensity of cigarettes, (2) describe an approach and present a model for assessing economic impacts, and (3) give findings for selected case analyses.

The report is organized into five main sections, 3 appendices, and an executive summary. The remainder of section 1 outlines the technical approach, describes the scope of the study, and discusses some constraints. Section 2 describes five hypothetical modifications to cigarette design which are later used in the case analyses. Section 3 explains why modifying cigarettes in various ways would be expected to have economic impact, and identifies major categories of impact. Section 4 discusses the economic impact model which was developed to enable quantitative evaluation of the impacts of modifying cigarettes. Section 5 presents all the input data and the results for selected case analyses, discusses the sensitivity of findings to key data and assumptions, summarizes the impact analyses, and discusses implications. The three appendices give additional information on the economic impact model and results of the case analyses: appendix A derives the solution equations of the supply and demand equilibrium model; appendix B lists equations of the health component of the economic impact model; and appendix C shows detailed tables of impact from which summary tables in section 5 were prepared. Supporting studies performed for the TSG by consultants are referenced in section 5, and are provided in Reports 5 and 6 of the TSG reports.

1.3 Technical Approach and Scope of Study

This study employs conventional techniques of benefit-cost analysis as set forth by Mishan and as described by Thompson.[1] This kind of approach entails identifying and valuing positive impacts (benefits) and negative impacts (costs) resulting from alternative courses of action, from the perspective of the decision maker, with the objective of assisting the decision maker to choose among the alternatives. Because in this application most categories of impact may be either positive or negative depending on the particular cigarette modification evaluated, and because multiple units of valuation are used rather than the monetary unit customary in benefit-cost analysis, the term "impact" is used to denote all changes rather than the terms "benefit" and "cost," and the study is termed an "impact analysis."

Familiarity with the general approach of impact or benefit-cost analysis is useful for understanding this study. Therefore, a brief overview of the approach and a discussion of some key issues are given before turning to the specifics of the study.

The simplest and most manageable form of benefit-cost analysis is that applied to a private sector decision where all effects may be combined and expressed as a single kind of effect, measurable in dollars. An example is an analysis of the impacts of alternative plant locations on the accounting profitability (net benefits) of a company. Benefit-cost analysis in support of public decisions, in contrast, tends to encompass broader concerns and multiple dimensions

[1] *See E. J. Mishan, Cost-Benefit Analysis: An Introduction (New York, NY: Praeger Publications, 1976); and Mark S. Thompson, Benefit-Cost Analysis for Program Evaluation (Beverly Hills, CA: Sage Publications, 1980.)*

which cause greater complexity and often give rise to difficulties both in theory and in practice.

The variety of concerns addressed by public program analysis causes the accounting profitability approach of the private company to be inadequate in most cases. For example, effects such as air pollution, which may be external to a private sector evaluation, are important factors to be included in public decision analysis. Effects in one sector may be offset to some extent by compensating effects in other sectors. Beyond the direct and indirect effects of an action, there may be important "global effects" to consider in a public sector program decision that do not arise in the analysis of private sector programs. Global effects reflect a special societal perspective beyond the simple aggregation of individual effects, such as public satisfaction that the disadvantaged are cared for; they arise solely from people's knowledge that the impact exists.

As more impacts are considered, it becomes increasingly difficult in practice to express all impacts in monetary units acceptable to a body of decision makers.[2] Distribution effects further complicate the analysis as some people, groups, or sectors lose and some gain, and associated questions of equity (fairness) arise. Even if all impact values were to be commensurable (measurable in the same units, such as dollars), and even if there were no problems of overlapping effects which would cause double counting of impacts, it would not be correct to aggregate all impact measures in a public program analysis unless a clear set of weights exists. As Thompson points out, when the analyst is unsure of the relative importance the decision maker places on different kinds of effects, a recommended approach is to report estimates of the various impacts separately, combining only those that are clearly commensurable.[3]

This study is characterized by multiple impacts, not all of which can practically be valued in dollars. In addition, distribution issues arise as some groups lose and some gain from a given modification in cigarette design. Impacts are analyzed by category, without aggregation across categories. Impacts are not aggregated for three major reasons:

(1) Different units of measure and different periods of coverage;

(2) The fact that impacts in one segment might cause compensating impacts in other segments, not fully accounted for in the impact model; and

(3) The assumption that a unit change in impact in one sector is not necessarily to be weighted equal to a unit change in another sector.

It is left to the decision maker to make trade-offs among the different impacts.

Other aspects of the technical approach are summarized under applicable subheadings below:

Cigarettes Only: The study treats cigarettes only, omitting little cigars which are also referenced in the legislation, for two reasons: (1) cigarettes are by far the dominant smoking material in smoking-related fires, and (2) data are more readily available for cigarettes than for cigars. Omitting little cigars from the study is consistent with the decision of the TSG, and is expected to result in an insignificant understatement of total impact.

Cigarette Modifications: Related studies of cigarette ignition propensity were carried out concurrently with the economic impact assessment. Results of the studies of technical feasibility were not available until near the end of the economic study. In order to carry out the economic impact analysis, it was necessary to select hypothetical cigarette design modifications for study without knowing their predicted impacts on fire losses. Five modifications were selected upon which to base the economic impact analysis, using two criteria:

(1) The hypothetical modifications were to be promising methods of reducing ignition propensity; and

(2) Together the hypothetical modifications were to cover the major physical descriptors of cigarettes – tobacco blend, paper, and size.

Because the economic impact model is designed to address all of these aspects of cigarettes, it is sufficiently flexible to accommodate other modifications that might be proposed at a later time.

Ignition Performance Results: In the absence of completed laboratory analysis of the ignition propensity, the economic impact analysis was performed based on three alternative percentage reductions in fire losses: (1) 25 percent (2) 50 percent and (3) 75 percent. This approach provides benchmark levels of performance against which performance estimates based on laboratory results can be compared when they become available.

Types of Impacts and Sectors of the Economy Covered: An objective of the study is to cover the more significant impacts of the hypothetical modifications on designated sectors of the economy. Of prime interest are the impacts on the general public from having fewer smoking-related fires. Also of interest are potential second-order impacts, such as impacts on the cigarette industry from changes in production costs and sales, on tobacco farmers from changes in demand for leaf tobacco, on consumers from changes in smoking, on workers from changes in employment opportunities, and on the Federal government from changes in excise tax revenue. There may impacts on other industries not covered, such as the paper industry, chemical industry, and machinery industry, but these are expected to be less

[2] *In performing benefit-cost analysis, an attempt is usually made to value impacts in dollars because this has the advantage of allowing diverse impacts to be compared, and a measure of overall impact (e.g., net benefits or benefit/cost ratio) computed for each course of action.*

[3] *Thompson, Benefit-Cost Analysis, p. 80.*

important and are beyond the scope of coverage of this study. Changes in the costs of paper, chemical additives, and machinery replacements resulting from cigarette modifications are taken into account in the impact calculations for the cigarette industry.

Modeling: To allow quantitative estimation of economic impacts, a mathematical economic impact model was developed. It consists of a series of integrated modules which represent each of the above sectors of the economy to be studied. It is an equilibrium model in the sense that a stable economic condition is assumed before and after the fire-safety of cigarettes is changed. The availability of data was taken into account in developing the model so that it could be applied to produce quantitative estimates. Although the model can be exercised with data different from that used in the case examples, it requires that the same data structures be used. This model is the most comprehensive available for estimating a wide variety of impacts that can result from changes in cigarette design, production costs, and demand.

Case Examples: Thirty separate analyses were performed by executing the economic impact model with selected data and assumptions. The results are intended to suggest the order of magnitude of impacts under alternative conditions. For conditions other than those specified, different results would be obtained from the model.

Data: Much of the data used in executing the economic impact model for the case examples are from supporting studies, performed by consultants engaged under separate contract by the CPSC with approval by the TSG. These data are presented and described in volumes 5 and 6 of the TSG reports. The accuracy of these data has not been verified by the National Bureau of Standards.

Period of Time Covered and Discounting: A question that arises in performing an impact study is the period of time to be covered. If measurable impacts are expected to occur as one-time events, they can be stated as lump-sum amounts. If they are expected to recur in approximately uniform amounts annually, they can be measured for one year and stated as annually recurring amounts. But if impacts vary significantly over time, the time dimension over which impacts are assessed becomes important.

Modifying cigarettes for fire safety entails impacts which were expected to have a significant time dimension and one that likely varies by type of impact. For example, the size of the smoking-related fire problem was expected to change over time even without a modification in cigarettes because of changes in smoking habits, changes in the prevalence of ignitable materials and changes in the level of fire protection. A changing baseline of fire losses means that the fire-related impacts from modifying cigarettes would be expected to change each year. In contrast, the effect of a cigarette modification on a given smoker's consumption rate or decision to start or stop smoking was expected to be a one-time event, not a repeating one, although the consequences of the behavior change would accrue over his or her remaining lifetime.

Because the time dimension was expected to be significant in computing fire-loss impacts, the model was structured to allow specification of a study period over which fire-loss impacts would be assessed. For the case examples, a study period of 10 years was specified to match the period over which it was believed base-line changes could be projected.

A ten-year study period was also used in the case examples to assess health impacts. At the time cigarettes are modified, all smokers who would be expected to incur future health effects from a change in smoking within the 10-year study period, are accorded a one-time change in smoking, with health consequences assessed over their remaining lives.

Consumer impacts, cigarette industry impacts, tobacco farming impacts, tax impacts, and employment impacts are all reported only for the first year they are estimated to occur. The extent to which they recur depends on alternative opportunities and the mobility of resources in the economy.

Another question which arises in performing the study is what to assume regarding the timing of implementation and the extent of the changeover. Two alternative implementation times are assumed in the study: (1) immediate implementation, and (2) a four-year delay. In either case, it is assumed that both before and after the modification, cigarettes can be described by a single, homogeneous design.

Conventional practices of benefit-cost analyses are followed, whereby future amounts are adjusted to their time-equivalent present value amounts; i.e., as though all future amounts occurred immediately as a lump-sum amount. This is necessary for a valid economic comparison of amounts which occur at different times.

2. Cigarette Modifications

2.1 Five Hypothetical Cigarette Modifications

At the direction of the TSG, five hypothetical cigarette modifications are used in the study. They are used to facilitate model development, to allow identification of types of potential impacts, and to test the order of magnitude of impacts which may result from representative modifications. Hypothetical modifications are used because the results of laboratory experiment upon which more definitive prototype cigarette designs might have been based were not available. The five selected are identified by type and briefly described in table 2.1.

Note that inclusion of these particular modifications in the study does not indicate that they are necessarily the best ways of improving cigarette fire safety. Other approaches may be superior. But this selection – (1) a reduction in cigarette circumference to increase burn rate, (2) an increase in the percentage of expanded tobacco to decrease the available fuel, (3) an additive to the blend to cause self-extinguishment, (4) an increase in the weight of the paper (with porosity held constant), and (5) a decrease in the porosity of the paper (with weight held constant) to increase the insulating function of the paper–covers each of the major physical components of cigarettes. To treat these modifications requires development of a versatile model capable of treating a modification of any major cigarette component. It is expected that other cigarette modifications that may be proposed at a later time also can be evaluated with the economic impact model, if specific cost data are provided in the required format.

2.2 The Baseline Cigarette

To provide a standard or baseline against which the modified cigarettes can be compared, a "prevalent pre-modification cigarette" is defined. This prevalent cigarette is assumed to have a tobacco column blended of about 35 percent flue-cured, 32 percent burley, 13 percent Maryland and oriental, and 20 percent reconstituted tobacco, plus flavorings. Its total column length, including filter, is about 85 mm long, and it is about 25 mm in circumference. Its paper is a single, smooth layer, made from flax straw, weighing about 24 g/m², with a porosity of about 35 Coresta units, about 65 mm long and 27.5 mm wide (which exceeds the cigarette circumference to allow overlap).

It is assumed that each modification is to this prevalent cigarette. It is further assumed that all domestic cigarettes are modified uniformly, either immediately or after a four-year delay.

Table 2.1 Five Cigarette Modifications Selected For Impact Assessment

Type of Modification	Specification
1. Change in Circumference	Decrease from 25 mm to 21 mm
2. Change in Tobacco Blend	Increase Expanded from 25% to 50% of Blend
3. Self-Extinguishing Chemical Additive to Blend	Add 150 g of Chemical to Blend per 1000 Cigarettes
4. Change Paper	Increase Paper Weight from 24 g/m² to 32 g/m²
5. Change Paper	Decrease Paper Porosity from 35 to 10 Coresta Units

3. Potential Impacts

This section investigates the impacts which might be anticipated from reducing cigarette ignition propensity, how those impacts might be valued, and special issues and uncertainties which arise in attempting measurement. In identifying types of impact, the perspective taken is that of the U.S. Congress with concern for all persons, groups, and sectors affected.

3.1 Sources of Impact

As a starting point, let us consider why changing the ignition propensity of cigarettes may have economic impacts. Knowing why impacts occur will be helpful in determining what impacts are likely to result from given cigarette design modifications.

The most obvious and direct source of impact is changing the probability that a cigarette will cause an unwanted fire. The expected results are fewer deaths and injuries from smoking-related fires, and less property damage.

Another source of impact is changing the kinds or quantities of raw materials, labor, and production processes required to produce cigarettes. Even if there were to be no change in overall production costs, suppliers of raw materials, labor, and machinery would experience direct impacts as more is demanded of some factors of production and less of others.

But changing the mix and quantities of inputs generally will change production costs, which means a change in the supply of cigarettes, i.e., a change in the various quantities of cigarettes which sellers are willing and able to make available for sale at possible alternative prices during a given period of time, all other things remaining the same. A change in supply will affect the quantity of cigarettes sold and the wholesale and retail prices at which they are sold. A change in cigarette price and sales can be expected to affect the revenue of cigarette manufacturers, of tobacco producers, and of other suppliers of raw materials, labor, and equipment. In turn, consumers, businesses and government will likely be affected. And, in addition, secondary impacts on fire losses due to price-induced changes in cigarette consumption can be anticipated.

A further source of impact may be changes in cigarette attributes other than ignition propensity and price, such as taste, appearance, tar, nicotine, and carbon monoxide content, and tendency to stay lit. Changes in these attributes may change the demand of consumers for cigarettes, i.e., the various quantities of cigarettes which buyers are willing and able to purchase at possible alternative prices during a given period of time, all other things remaining the same. A change in demand will affect cigarette sales and prices, thereby affecting cigarette manufacturers, tobacco producers, consumers, business, government, suppliers of raw materials, labor, and machinery, and potential victims of fire loss. Changes in chemical potency of cigarettes may directly affect consumer health.

In brief, impacts may stem from any or all of the following four sources:

(1) Change in ignition propensity;

(2) Change in the mix or quantities of raw materials, labor, and/or production processes for manufacturing cigarettes;

(3) Change in the costs of producing cigarettes; and

(4) Change in the taste, potency, and other smoking attributes of cigarettes.

A first step in estimating the impacts of a given cigarette modification is to ask which of these sources of change are likely to occur.

3.2 Types of Impact

A second step in assessing impact is to decide the level of coverage. This study focuses on the fire loss impacts, the primary or "first-order" effects. It also includes secondary or "second-order" effects which may be important depending on how the modification is accomplished. Impacts are grouped into the following categories:

A. First-Order Impacts

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(1) Lives/life-years saved due to fewer cigarette fires;

(2) Cigarette-fire injuries avoided; and

(3) Property loss reductions.

B. Second-Order Impacts

(1) Cigarette industry impacts;

(2) Tobacco farming impacts;

(3) Health impacts;

(4) Consumers' surplus impacts;

(5) Employment impacts;

(6) Excise tax revenue impacts; and

(7) Other impacts.

Each of these potential types of impacts is discussed briefly below. The discussions address the appropriate units of valuation and key issues for measurement. Potential impacts not included in the model are noted.

3.2.1 First-Order Impacts: Reductions in Cigarette-Fire Losses

Reductions in fire losses from smoking-related fires are the most direct impacts of reducing cigarette ignition propensity. If cigarettes were to be made completely fire safe, each year about 1500 people fewer would die in fires, roughly 7000 fewer would be injured in fires, and nearly half a billion dollars in property losses would be avoided. Some downward trend in cigarette fires is projected over the coming years due to reductions in cigarette consumption, increases in the prevalence of fire-resistant bedding and upholstery, and improvements in fire mitigation technologies. Over the next 10 years, for example, deaths and injuries from cigarette fires are projected to drop by roughly 20 to 25 percent and property loss by about 10 percent. Despite this downward trend, the savings potential from fire-safe cigarettes remains relatively strong through at least the mid-1990's.[4]

The size of direct fire loss impacts depends not only on the magnitude of the cigarette-fire problem, but on achievable reductions in ignition propensity. As was indicated earlier, no distinction is made among the hypothetical modifications in their estimated first-order impacts, due to lack of data.

In addition to the direct fire loss impacts from a modification in cigarette design, second-order fire-loss impacts may occur. The secondary impacts stem from changes in cigarette consumption brought about by changes either in cigarette production costs (supply) or in other cigarette attributes (demand). While the direct fire-loss impacts are expected to be positive for all technically feasible design modifications, the secondary fire-loss impacts may be either positive or negative depending on how cigarette production costs and demand change.

The generally accepted unit for valuing property loss is dollars and that is the unit of value applied in this study. Property loss impacts are measured by applying designated percentage reductions to the projected baseline of smoking-related property losses, which are reported in dollars.

While there is little controversy over assigning a dollar unit of value to property loss, there is controversy over assigning a dollar unit of value to avoidance of death and injury. This does not mean that dollar valuation of life and limb is not often done—it is, generally according to one of the following three methods:

(1) Willingness-to-pay method;

(2) Earnings method; and

(3) Social valuation method.[5]

Dollar valuation of life and limb is done because it is useful for making decisions about programs that affect life safety, such as disease control and highway safety—programs which entail significant and varying amounts of capital expenditure and which have different effects on life safety. Even if dollar valuation is not made explicit, dollar values are implicitly placed on lives each time the government or private sector makes a capital investment decision which affects the probability of death and injury. At the same time, a number of arguments can be advanced against assigning dollar values to life and limb, and the approach is nearly always likely to cause difficulty as decision makers disagree among themselves as to the appropriateness of the dollar amount. At the request of the TSG, impacts on life and limb are not valued in dollars in this study. They are measured in terms of numbers of lives saved, with an alternative estimate provided of the equivalent life-years saved (since no lives are permanently saved), and numbers of injuries avoided.

The appropriate valuation of injury is particularly difficult, because fire injuries range from very minor to a degree of seriousness that would probably be perceived by many as worse than death. Yet they are reported simply as number of injuries in the fire statistics. In this study, direct injury impacts are measured by applying the assumed percentage reduction in ignition propensity to the total number of smoking-related injuries, without any breakdown by seriousness of the injury.

Indirect costs of fire losses, such as funeral bills, medical expenses associated with fire injuries, expenses due to loss of housing and clothing, and fire department costs and

[4] *John R. Hall, Jr., Final Report: Expected Changes in Fire Damages from Reducing Cigarette Ignition Propensity, report submitted to the Technical Study Group on Cigarette Fire Safety, August 1986, Table 1.*

[5] *For a discussion of these methods of life valuation, see Thompson, Benefit-Cost Analysis, pp. 184-220.*

other costs of fire loss mitigation fall outside the scope of study.

3.2.2 Second-Order Impacts

Cigarette Industry Impacts

A change in cigarette design may affect manufacturers of cigarettes by changing their manufacturing costs, product price, sales volume, and revenue. These effects result from changes in input requirements, causing a change in supply; they can also result from shifts in the demand for the cigarettes.

A reduction in ignition propensity may also change manufacturers' costs of litigation and reduce adverse publicity. The product liability theory increasingly applied to sustain law suits against cigarette manufacturers relates to "defects in design" and assumes that the manufacturer could have eliminated foreseeable dangers from the product.[6] By producing fire-safe cigarettes, manufacturers may reduce potential costs of litigation and adverse publicity arising from cigarette-caused fires.

If a cigarette design modification requires an increase in factors of production, unit costs rise, the price at which manufacturers are willing to supply cigarettes rises, and sales fall, other factors remaining the same. The resulting change in revenue depends on the price elasticity of demand for cigarettes, a measure of the responsiveness of the change in the quantity of cigarettes purchased to a change in cigarette price.[7] Given the relatively inelastic demand for cigarettes—as indicated by previous studies[8]—manufacturers' revenue can be expected to increase with a decrease in supply, and decrease with an increase in supply, because the change in price will not be fully compensated by a change in sales.

If a design modification changes those attributes of cigarettes associated with smoking satisfaction, consumer demand for the product also can be expected to change. A cigarette perceived by consumers as inferior would be expected to generate less demand and one perceived as superior, more demand. Less demand tends to cause price and cigarette sales to fall, and, in turn, to reduce manufacturers' revenue. An increase in demand tends to have the opposite effect. While it appears fairly certain that an inferior tasting cigarette or one with obnoxious handling characteristics would elicit reduced demand, and vice-versa, it is not easy to say by how much. There is little publicly available information which would enable estimation of consumer response to the hypothetical modifications.[9]

Another factor which complicates the estimation of demand-shift impacts on the cigarette industry is uncertainty over the response in consumer demand to cigarette modifications entailing changed levels of nicotine. As observed by Leu and Schaub,

> *Cigarette smoking is associated with considerable physiological and social dependency. . . .The tenacity of smoking patterns is explained by influences of the social environment, . . . by physiological processes, regulating the frequency of smoking (and possible other intake parameters) within characteristic limits to maintain a certain nicotine level . . ., or both . . .*[10]

The social dependency factor is taken into account in the economic impact model by the use of empirically estimated price elasticity of demand parameters. The portion of the physiological dependency factor which is satisfied by the frequency of smoking (as distinct from changes in inhalation) is taken into account in the economic impact model by allowing shifts in the demand for cigarettes. But how much to shift demand for a given change in nicotine is highly questionable. It may be that a large part of the compensation occurs through changes in the manner cigarettes are smoked, such as depth and length of inhalation, rather than in purchases.

The impacts of design modifications on the cigarette industry are measured as changes in millions of cigarettes sold and millions of dollars of revenue. These impacts are reported for one year only, the first year they are assumed to occur. Although the change in annual revenue in the cigarette industry may recur, it would be expected that in the long run unemployed resources will be deployed to other uses.

To the extent that manufacturing fire-safe cigarettes were to reduce future costs of litigation and adverse publicity, it would give rise to positive cigarette industry impacts. These impacts are not included in the quantitative impact assessments of chapter 5.

Tobacco Farming Impacts

Modification of cigarettes can also be expected to affect tobacco farming, because the demand for tobacco is derived from cigarette sales. If a design modification causes a shift in the supply or demand for cigarettes, the derived demand for tobacco also can be expected to change. If a shift in cigarette supply results from a change in non-tobacco inputs only, the derived change in tobacco demand will reflect a change only in the quantity of cigarettes sold; but if the shift in supply results from a change in tobacco

[6] *Donald W. Garner, "Product Liability in Cigarette-caused Fires," New York State Journal of Medicine (July 1985), p. 322.*

[7] *Algebraically, price elasticity is defined as the ratio of the percentage change in the quantity demanded to the percentage change in the price charged.*

[8] *Eugene M. Lewit and Douglas Coate, "The Potential for Using Excise Taxes to Reduce Smoking," Journal of Health Economics, no. 1 (1982), pp. 121-145.*

[9] *Gary T. Ford, John P. Brown, and John E. Calfee, "The Costs and Benefits to Smokers of Reduced Flammability Cigarettes," Report No. 6, Technical Study Group.*

[10] *Robert E. Leu and Thomas Schaub, "Economic Aspects of Smoking," Effective Health Care, vol. 2, no. 3 (1984).*

inputs, the derived change in tobacco demand will reflect not only a change in the quantity of cigarettes sold, but also in the tobacco content of each cigarette.

Impacts on tobacco farming are distributed among the following four different groups:

(1) Growers—those who manage the farming activity;

(2) Landowners—those who own the land on which the tobacco is grown;

(3) Quota holders—those who own the right to grow tobacco; and

(4) Farm laborers.

The impact of cigarette design modifications on tobacco farming is influenced significantly by government agricultural policy. Shifts in demand for tobacco can be responded to by a range of changes in quota allotments, causing varying combinations of adjustment in tobacco sales and price. This policy affects the distribution of revenue impacts among the above groups.

Tobacco farming impacts are likely to be highly concentrated in several states, particularly North Carolina and Kentucky, the major tobacco-producing states. The impact analyses of section 5, however, do not show impacts at the regional level.

Impacts on sales of tobacco are measured in millions of pounds of tobacco sold; impacts on tobacco revenue, in millions of dollars. Impacts are estimated for one year only, the first year they are assumed to occur. Changes in annual revenue from tobacco farming may persist as tobacco farmers are likely to find it difficult in the short-run to shift to other crops of equal or higher value.

Health Impacts

In addition to the impacts on life and limb associated with fire losses, there are potential health impacts associated with modification-induced changes in cigarette consumption and the chemical composition of cigarettes. At a press conference releasing the 1986 Surgeon General's Report of *The Health Consequences of Involuntary Smoking,* Surgeon General C. Everett Koop, M.D., stated:[11]

Previous reports have documented the tremendous health burden caused by tobacco use, particularly regular cigarette use. In the 1982 report on cancer we concluded that cigarette smoking was the single largest cause of excess cancer mortality in the United States; in 1983 our report on cardiovascular disease identified cigarette smoking as the most important modifiable risk factor for coronary heart disease; and in 1984 cigarette smoking was found to be the major cause of chronic obstructive lung disease in the United States population.

The scientific data which establish these increased risks for disease among smokers is now overwhelming, totaling more than 50,000 studies from dozens of cultures. It is estimated that smoking is responsible for well over 300,000 deaths annually in the United States, representing approximately 15 percent of all deaths.

By relating disease incidence to smoking levels, and estimating the economic consequence of disease, the economic impacts of changes in smoking levels can be estimated. Changes in cigarette consumption associated with different design modifications can thereby be translated into estimated health impacts.

Health impacts are estimated in the study as changes in incidence-based lifetime medical costs measured in expected value dollars, and as changes in life expectancies (i.e., life years saved or lost) attributable to a modification of cigarette design. The impact measures do not include changes in the dollar value of productive output foregone or changes in the quality of life due to modification-induced changes in morbidity, disability, and premature mortality.

Health impacts from changes in the chemical composition of cigarettes can be estimated by the economic impact model if the necessary data are provided. However, the appropriate values to assign to the parameters which define the relationship between the tar, nicotine, and CO content, and smoking-related medical costs and life expectancies for the five modifications are unknown.

Health issues not addressed by the economic impact model and not taken into account in the health data used in the case analyses include: (1) omission of passive smoking effects; and (2) possible understatement of health costs to women smokers due to recent changes in inhalation patterns and increased use of oral contraceptives.

Consumers' Surplus Impacts

"Consumers' surplus" is used in benefit-cost analysis of public programs as a measure of the net change in welfare caused by a project or policy—an increase in consumers' surplus indicating an improvement in social welfare, and a decrease, a detriment. Consumers' surplus is defined as the amount a user would be willing to pay for a good, a service, or a right less its cost to him or her. Consumers' surplus may be increased either by increasing consumers' willingness to pay (i.e., increasing demand) or by decreasing production cost (i.e., increasing supply), since either increases the excess of willingness to pay over cost. Hence, a policy which reduces the cost of cigarettes to consumers, without adversely affecting cigarettes, or which increases consumer demand for cigarettes, is considered to increase consumers' surplus. The economic impact model is capable of measuring the change in consumers' surplus resulting from both changes in cost and changes in demand.

Because the consumers' surplus concept is measured by the willingness to pay based on the observed market price actually paid, it fails to capture certain nonmarket payments

[11] *"Remarks by C. Everett Koop, M.D., Surgeon General, at Press Conference Releasing the 1986 Surgeon General's Report on The Health Consequences of Involuntary Smoking," Press Release, U.S. Dept. of Health and Human Services, (December 16, 1986), p. 1.*

that consumers may make implicitly, whether or not they are aware of them. These include such nonmarket costs as health and fire risks.

Implicit in the consumers' surplus concept is the assumption that tastes and preferences of consumers are revealed by their consumption decisions, and that consumption provides satisfaction to the consumer. The application of the consumers' surplus measure assumes free choice and the absence of third party or external effects. To the extent that physiological and social dependencies prevent the smoker from making free choices about consumption, there is a market failure, and consumers' surplus becomes a questionable indicator of consumer satisfaction. Similarly, if passive smokers who wish not to inhale environmental smoke suffer a decrease in consumer satisfaction as active smokers experience a gain, and vice versa, it becomes a questionable measure.

Employment Impacts

Employment impacts will be induced directly if the input requirements for producing cigarettes change, thereby changing the mix and numbers of jobs. Indirect employment impacts may result if a design modification triggers a change in cigarette or tobacco sales.

Employment impacts are likely to be concentrated in the major tobacco-producing and cigarette-manufacturing regions. But the impact assessment in section 5 does not estimate impacts by region.

To the extent that displaced workers can move into other jobs at equal wages, employment losses will be offset. But if wages are lower in alternative employment opportunities or if displaced workers cannot find alternative employment, losses in worker income will persist.

Employment impacts estimated by the economic impact model include the direct impacts resulting from changes in the cigarette production process as well as indirect impacts resulting from changes in the level of tobacco and cigarette production. The employment impacts are measured in full-time equivalent jobs.

Cigarette Excise Tax Revenue Impacts

Included in the wholesale price of cigarettes to be sold in the domestic market is the federal excise tax of 8 dollars per thousand. In addition, included in the retail price of cigarettes are state and local taxes which vary widely but on a sales-weighted average basis amount to just under 17 cents per package of 20 cigarettes, approximately equal to the revenue collected under the federal tax. Because these excise taxes are based on the quantity of cigarettes sold, the revenue generated by them will be affected directly in proportion to changes in domestic cigarette sales. These tax revenue impacts are included in the model and are to be interpreted as changes in transfer payments between different interest groups and not as impacts on resource costs. Federal excise tax is imposed on the basis of the quantity of cigarettes sold. Tax revenue, therefore, can be expected to rise if a design modification results in higher sales of cigarettes, and to fall with lower sales.

Other Impacts

Potential impacts not included in the model include the following:

(1) Other industry impacts, such as impacts on the paper, fertilizer, container, farm equipment, cigarette manufacturing equipment, chemical, transportation, and advertising and promotion industries;

(2) Multiplier impacts as each effect causes, in turn, still smaller effects in a ripple throughout the economy;

(3) Global impacts, such as public satisfaction that innocent people are suffering fewer losses from smoking-related fires for which they are not responsible;

(4) Regional impacts, as some of the major impacts, namely tobacco farming, cigarette manufacturing, and employment, will tend to be concentrated in several states.

4. The Economic Impact Model

The purpose of the economic impact model is to permit quantitative estimation of each of the impacts discussed in section 3.0. Because most cigarette design modifications are likely to lead to a change in manufacturing costs, a method of tracing such cost changes through to all of the impact categories is needed. This need led to the development of a supply and demand equilibrium model of the leaf tobacco and cigarette industries. This model lies at the core of the impact model because the estimates it provides of the price and quantity changes in the tobacco and cigarette markets form an essential component of all of the impact estimates. For example, the results of the supply and demand model permit immediate estimation of such impacts as the changes in tobacco growing revenue, cigarette company revenue, and federal excise tax revenue. In addition, the estimate given by the model of the change in the quantity of cigarettes sold in the domestic market is the key value in determining all of the second-order fire loss, health, and employment impacts. The first subsection describes the supply and demand equilibrium model, and the last three subsections discuss the economic impact categories that require additional modeling and that derive from both the direct (that is, independent of a change in cigarette consumption) effects of the product modifications and the indirect (that is, resulting from a change in cigarettes consumption) effects. Thus, there are a total of four models that are linked together to comprise the economic impact model:

(1) Supply and demand equilibrium model;

(2) Fire loss impact model;

(3) Health impact model; and

(4) Employment impact model.

4.1 The Supply and Demand Equilibrium Model

This subsection discusses the structure of the supply and demand equilibrium model, the data requirements of the model, and those economic impact categories that are addressed directly by the model.

4.1.1 Model Structure: Structural Equations, Endogenous and Exogenous Variables, Parameters, and Solution Equations

The two major industries affected by modifications to the design of cigarettes are the leaf tobacco industry and the cigarette manufacturing industry. The supply and demand equilibrium model is structured to address both of these industries with explicit equations representing the supply of and demand for tobacco and cigarettes in both the domestic and export markets. The model is called an equilibrium model because it is designed to compare the market equilibrium values before and after the proposed cigarette modifications. The model offers such comparisons readily because all of the variables are expressed as proportional changes and the solution of the model expresses each of the price and quantity variables as a function of the changes in tobacco costs, paper costs, and other manufacturing costs brought about by the cigarette modifications.

The supply and demand model consists of the nine equations presented in Table 4.1. The definitions of the endogenous variables are presented in Table 4.2. The parameters used in the structural equations to compute the immediate impacts of the supply and demand model are explained in Table 4.3. The exogenous variables are defined in Table 4.4. The operator, E, before a variable indicates that the variable is in proportional change or log differential form (i.e., $EX=dX//X$). Thus, EP_{td} means the log differential of the price of domestic tobacco and when multiplied by 100, can be interpreted as the percentage change in the price of domestic tobacco.

Eq (1) is a standard demand equation which expresses the proportional change in the number of cigarettes demanded in the domestic market as a function of the proportional change in the price of domestic cigarettes and of the exogenous change in the demand, ED_{cd}, possibly due to taste changes resulting from the modifications. Variables such as the price of cigarette substitutes and consumer incomes are not explicitly included in the model because they are assumed to be unaffected by the modifications. The

coefficient of EP_{cd} the wholesale price of cigarettes, is the elasticity of demand with respect to the wholesale price and is interpreted as the percentage change in quantity demanded per percentage change in price. For example, if the elasticity were 0.3, a ten percent increase in the domestic wholesale price would mean a 3 percent decrease in the quantity demanded. Eq (2) is the same kind of demand equation for the export market, and Eq (3) represents the total of the two markets and is the weighted average of the changes in each market, weighted by their quantity shares.

Eq (4) represents the supply of cigarettes in the domestic market. The domestic supply is based on a cost function that relates changes in the price of cigarettes to changes in production costs of each component of the manufacturing process. Thus, the domestic price is a function of the price of tobacco and of the quantity of tobacco per cigarette as well as of the paper and other costs. Each cost component is weighted by its respective cost share. This specification of domestic supply implies that changes in the unit cost of manufacturing will eventually be fully reflected in the real price of cigarettes, other factors being equal. The use of this specification is appropriate for industries with little evidence of monopoly behavior, such as the cigarette industry.[12] Note that the model predicts an expected change in the real (inflation free) price, that the adjustment may be gradual, and that the change is measured in reference to what would have happened in the absence of the cost change.

Eq (5) represents the supply of cigarettes in the export market. The export price is not subject to the federal excise tax so that the proportional changes have to be weighted accordingly. In addition, the export price differs from the domestic price by the extent to which the modification costs are NOT incurred for exported cigarettes. Because of this parameter, the model is completely flexible with respect to whether and to what extent cigarettes sold in the export market are assumed to be subject to the design modifications.

Eq (6) represents the derived demand function for domestically grown tobacco used by U.S. manufactured cigarettes. The quantity demanded depends on its price, the total number of cigarettes produced, and the content of tobacco per cigarette. In Eq (7) the quantity of domestic tobacco demanded in the export market is a function solely of the price. Eq (8) represents the total amount of tobacco demanded in the two markets and is the weighted average of the changes in each market, weighted by their quantity shares. The supply of domestic tobacco is given in Eq (9) and is a function of the price and of the parameter representing the supply elasticity of tobacco which is determined primarily by federal agricultural policy.

This supply and demand model was adapted from one originally developed to assess the impacts of changes in federal cigarette excise tax policy.[13] To construct a model that permits analysis of the effects of cigarette design modifications, five of the nine equations of the tax policy model had to be respecified. Eqs (1) and (2) were modified to allow for domestic and foreign consumer responses to the design modifications. Eq (4) had to be restructured to permit analysis of the changes in tobacco content, paper costs, and other manufacturing costs caused by the modifications. Eq

Table 4.1 Structural Equations of the Supply and Demand Model in Proportional Change Form

1. $EQ_{cd} = -\eta_{cd}EP_{cd} + \overline{ED}_{cd}$

2. $EQ_{ce} = -\eta_{ce}EP_{ce} + \overline{ED}_{ce}$

3. $EQ_c = \beta_{cd}EQ_{cd} + (1 - \beta_{cd})EQ_{ce}$

4. $EP_{cd} = \alpha_{td}EP_{td}\overline{F}_{td} + \overline{EC}$,

   where $\overline{F}_{td} = 1 + \overline{EU}_{td}$, and $\overline{EC} = \alpha_{td}\overline{EU}_{td} + \alpha_K\overline{EK} + \alpha_M\overline{EM}$

5. $EP_{ce} = \gamma(EP_{cd} - \theta\overline{EC} - \theta\alpha_{td}EP_{td}\overline{EU}_{td})$, where $\gamma = 1/(1 - \alpha_T)$

6. $EQ_{td} = -\eta_{td}EP_{td} + EQ_c\overline{F}_{td} + \overline{EU}_{td}$

7. $EQ_{te} = -\eta_{te}EP_{td}$

8. $EQ_t = \beta_{td}EQ_{td} + (1 - \beta_{td})EQ_{te}$

9. $EQ_t = \epsilon EP_{td}$

Table 4.2 Definitions of Endogenous Variables Used in the Supply and Demand Model

Symbol	Definition	Units
Q_{cd}	Quantity of U.S. cigarettes sold in domestic market	#/year
Q_{ce}	Quantity of U.S. cigarettes sold in export market	#/year
Q_c	Total quantity of U.S. cigarettes produced	#/year
Q_{td}	Quantity of U.S. tobacco sold in domestic market	lbs/year
Q_{te}	Quantity of U.S. tobacco sold in export market	lbs/year
Q_t	Total quantity of U.S. tobacco produced	lbs/year
P_{cd}	Price of cigarettes sold in domestic market	$/1000
P_{ce}	Price of cigarettes sold in export market	$/1000
P_{td}	Price of U.S. tobacco sold in domestic market	$/lb

[12] *Daniel A. Sumner, "Measurement of Monoply Behavior: An Application to the Cigarette Industry," Journal of Political Economy, vol. 89, no. 5 (October 1981), pp. 1010-1019.*

[13] *Daniel A. Sumner and Michael K. Wohlgenant, "Effects of an Increase in the Federal Excise Tax on Cigarettes," American Journal of Agricultural Economics, Vol. 67, No. 2 (May 1985), pp. 235-242.*

(5) was respecified because federal tax policy is not being changed by the cigarette modifications and to give the model flexibility to accommodate alternative assumptions about the extent to which exported cigarettes share in the costs of the design modifications. Some exported cigarettes may be modified because they share the same production facilities. Eq (6) was restructured to account for changes in the domestic tobacco content of cigarettes resulting from the design modifications. The remaining four equations required no changes.

The system of nine equations presented in table 4.1 can be solved using the method of substitution. The objective is to express at least one of the endogenous variables in explicit form independent of the other endogenous variables. Thus, this variable would be a function exclusively of the known parameters and the known exogenous variables. This function permits the direct computation of the equilibrium solution value of the variable, which in turn can be used to compute the solution values of the remaining endogenous variables. The key endogenous variable in this system of equations turns out to be EP_{td} the domestic wholesale price of tobacco. The explicit form solution for this variable is derived in detail in appendix A.

The solution equations for the supply and demand model are presented in Table 4.5. The equations are numbered in the order in which they are to be used for computing the solutions to each of the endogenous variables. Once the first equation has been used to compute the proportional change in the domestic price of tobacco, the answer is substituted into the second equation to obtain the price change for domestic cigarettes. Then these results can be used to solve the third equation to get the change in the price of exported cigarettes. In a similar fashion, the remainder of the endogenous variables can be solved.

4.1.2 Data Requirements for the Supply and Demand Model

To use the solution equations to obtain quantitative economic impact estimates, considerable data requirements must be satisfied. The first requirement is for specific values for the parameters listed in table 4.3. There are six elasticities to be established. The elasticity of domestic demand for cigarettes has been studied extensively. Warner summarizes a number of recent estimates of this elasticity with respect to the retail price of cigarettes, and they range from 0.4 to 1.3.[14] Such a retail elasticity can be converted to the wholesale equivalent needed by the model by multiplying by the ratio of wholesale to retail prices. The other five elasticities are discussed in some detail by Sumner and Wohlgenant. The five cost share parameters can be established by dividing relevant cost data available from the US Department of Agriculture (USDA) by the wholesale price of cigarettes. The two quantity shares for cigarettes and tobacco are available from the

Table 4.3 Definitions of Parameters Used in the Structural Equations and in the Computation of the Immediate Impacts of the Supply and Demand Model

Symbol	Definition
η_{cd}	Price elasticity of domestic demand for cigarettes
η_{ce}	Price elasticity of export demand for cigarettes
η_{td}	Derived demand elasticity for domestic tobacco
η_{te}	Price elasticity of export demand for tobacco
α_{td}	Cost share of domestic tobacco in cigarettes
α_K	Cost share of paper in cigarettes
α_T	Cost share of federal excise tax in cigarettes
α_M	Cost share of other manufacturing costs in cigarettes
α_L	Cost share of lease rates in tobacco production
β_{cd}	Quantity share of U.S. cigarettes in domestic market
β_{td}	Quantity share of U.S. tobacco in U.S. cigarettes
μ	Elasticity of marginal cost of tobacco
ε	Agricultural policy response elasticity for tobacco
θ	Share of modification costs not included in exported cigarettes

Table 4.4 Definitions of Exogenous Variables Used in the Supply and Demand Model

Symbol	Definition	Appearing in Structural Equation(s)
$\overline{ED}_{cd}$	Proportional Change in Domestic Demand for Cigarettes	1
$\overline{ED}_{ce}$	Proportional Change in Export Demand for Cigarettes	2
$\overline{EU}_{td}$	Proportional Change in Unit Domestic Tobacco Content per Cigarette	4, 5, 6
$\overline{EK}$	Proportional Change in Paper Cost per Cigarette	4
$\overline{EM}$	Proportional Change in all Other Cigarette Manufacturing Costs	4, 5

[14] *Kenneth E. Warner, "Consumption Impacts of a Change in the Federal Excise Tax." The Cigarette Excise Tax: April 17, 1985. Smoking Behavior and Policy Conference Series (Cambridge, MA: Harvard University, Institute for the Study of Smoking Behaviour and Policy, 1985), pp. 88-105.*

Table 4.5 Equations Used to Compute the Solution Values for the Endogenous Variables, in the Order of Computeration

1. Price of Domestic Tobacco:

$$EP_{td} = \bar{F}_{td}\alpha_{td}[\beta_{cd}(\overline{ED}_{cd} - \eta_{cd}\overline{EC}) + (1 - \beta_{cd})(\overline{ED}_{ce} - \eta_{ce}\gamma(1 - \theta)\overline{EC}) + \overline{EU}_{td}]/[\epsilon + \lambda],$$

where $\lambda = \beta_{td}\alpha_{td}\bar{F}_{td}[\beta_{cd}\eta_{cd}\bar{F}_{td} + (1 - \beta_{cd})\eta_{ce}\gamma(\bar{F}_{td} - \theta\overline{EU}_{td})] + \beta_{td}\eta_{td} + (1 - \beta_{td})\eta_{te}$

2. Price of Domestic Cigarettes: $EP_{cd} = \alpha_{td}EP_{td}\bar{F}_{td} + \overline{EC}$

3. Price of Exported Cigarettes: $EP_{ce} = \gamma(EP_{cd} - \theta\overline{EC} - \theta\alpha_{td}EP_{td}\overline{EU}_{td})$

4. Quantity of Domestic Cigarettes: $EQ_{cd} = -\eta_{cd}EP_{cd} + \overline{ED}_{cd}$

5. Quantity of Exported Cigarettes: $EQ_{ce} = -\eta_{ce}EP_{ce} + \overline{ED}_{ce}$

6. Quantity of Total Cigarettes: $EQ_c = \beta_{cd}EQ_{cd} + (1 - \beta_{cd})EQ_{ce}$

7. Quantity of Domestic Tobacco: $EQ_{td} = -\eta_{td}EP_{td} + EQ_c\bar{F}_{td} + \overline{ED}_{td}$

8. Quantity of Exported Tobacco: $EQ_{te} = -\eta_{te}EP_{td}$

9. Quantity of Total U.S. Tobacco: $EQ_t = \beta_{td}EQ_{td} + (1 - \beta_{td})EQ_{te} = \epsilon EP_{td}$

USDA report, *Tobacco: Outlook and Situation Report.* The share of modification costs not included in exported cigarettes is a policy parameter whose value can be selected between zero and one according to the preferred assumption.

The next set of data requirements focuses on establishing the proportional changes in each of the exogenous variables listed in table 4.4. If a modification is expected to alter significantly the taste of cigarettes, then the first two exogenous variables can be used to reflect the resulting shifts in demand in the domestic and export markets. The last three exogenous variables address possible changes in the costs of producing cigarettes due to the design modifications. The data needed to specify these changes must be in proportional change form and should be based on a study of the cost consequences of the modification for each of the three cost components. For example, if the modification calls for increased use of tobacco expansion so that 12 percent less tobacco would be used per cigarette, the value to be used in the model for EU_{td} should be −0.12. Similarly, if the modification calls for an increase in the weight of paper leading to a 25 percent increase in the cost of paper, then the value of EK in the model should be 0.25.

Once the values for the parameters are fixed and the values for the proportional change exogenous variables are chosen, solution values for each of the endogenous variables can be obtained directly from the solution equations in table 4.5. These solution values are stated in proportional change form and represent impacts of the design modifications in terms of the changes in prices and quantities in the domestic and export cigarette and tobacco markets. The solution values also provide the means to estimate other impacts of the modifications.

To determine the actual changes in the prices and quantities (in addition to the proportional or percentage changes), data are needed on the initial values for each of the variables, such as the total number of cigarettes and pounds of tobacco produced, and the current prices of cigarettes and tobacco. These initial or baseline values for the endogenous variables are available in the *USDA Tobacco: Outlook and Situation Report.*

4.1.3 Immediate Impacts Provided by the Supply and Demand Model

The immediate impacts addressed by the supply and demand model are the tobacco farming impacts, the cigarette industry impacts, and the tax and consumer impacts. These impacts are called immediate because their estimation requires no data besides the three categories needed by the supply and demand model itself: the values for the parameters, the exogenous change variables, and the initial values for the endogenous variables.

The tobacco farming impacts include changes in the price of tobacco and changes in the quantities of tobacco sold in the domestic and export markets. In addition, the change in tobacco revenue is computed with a breakout for the portion of revenue going to the owners of the tobacco growing rights, and the profits (Producers' surplus) going to the tobacco growers themselves.

The cigarette industry impacts include the change in the wholesale cigarette price and the changes in domestic and export sales. The change in total cigarette revenue from domestic and export sales net of the federal excise tax is also presented.

The tax and consumer impacts include the change in the revenue from the federal excise tax and the change in consumers' surplus due both to shifts in demand and changes in price and quantity.

Some of the immediate impacts discussed here are represented by one of the solution equations of the model already presented in table 4.5. The rest of the immediate impacts are computed using the equations given in table 4.6.

4.2 Fire Loss Impacts

To enable the economic impact model to estimate fire loss impacts of the cigarette modifications, three tasks are involved. First, data need to be developed on the annual fire loss rates projected over the study period and on the change in ignition probability expected from the modifications. Second, baseline data projections are needed on annual cigarette consumption over the study period. Third, a model is needed for computing each of the fire loss impacts based on these baseline data and on the results of the supply and demand model. Each of these tasks will be discussed in turn.

4.2.1 Fire Loss Data Requirements

Two types of fire loss data are required: (1) baseline fire loss data, and (2) percentage change in smoking-related fires. The necessary baseline fire loss data consist of projections over the study period of the annual incidence of death and injury and the dollar value of property damage caused by cigarette ignitions in the United States. These data have to be specified in reference to the annual consumption of cigarettes, so that the estimated fire loss impacts will reflect changes in consumption. Convenient units of measurement are the number of deaths and injuries per billion cigarettes and the constant dollar value of property damage per billion cigarettes due to cigarette-related fires. The second type of fire loss data addresses the expected change in the probability of ignition due to each cigarette design modification. These data have to be stated as proportional changes in the ignition probability. For example, suppose that a particular modification were estimated to lower the probability of ignition from 80 percent to 20 percent. This would imply a proportional change of −0.75 (i.e., −.60/.80) or a 75 percent decrease. Of course, if the modification caused changes in behavior, such as increased carelessness, the proportional change estimate would have to be adjusted.

4.2.2 Projection of Baseline Annual Cigarette Consumption

The fire loss data have to be integrated with cigarette consumption projections in order to arrive at an assessment of fire losses per quantity of cigarettes smoked. This subsection describes the derivation of the cigarette consumption projections for the years 1986 through 1995 for the resident U.S. population, ages 16 and over.

In developing the projection model, it was assumed that the consumption trend of the past ten years would continue into the next ten years. Hence, the cigarette consumption figures for the years 1976 to 1985 served as the basis for the consumption projections for the years 1986 to 1995. The method described below was used to estimate the future base-line cigarette consumption:

First, linear regression analysis was used to estimate the parameters for the intercept and the slope of the trend line for the years 1976 to 1985. Second, the estimated parameters were applied to the years 1986 to 1995 to predict per capita consumption. Third, the per capita figures were multiplied by the projected population figures for 1986 to 1995 to obtain the total projected cigarette consumption for those years. These figures are listed in table 4.7.

In the years after 1981 per capita cigarette consumption showed a marked decrease, presumably attributable for the most part to the greater than usual number of state excise tax increases in 1982 and to the rise in the federal excise tax from 8 cents per pack of cigarettes to 16 cents in January 1983. Tax increases have been a principal component of cigarette price increases,[15] and the responsiveness of cigarette consumption to prices is well documented elsewhere in this report.

For the specification of the regression equation a trend variable YEAR and a DUMMY variable are used. The dummy variable reflects the tax effects. Since the study period comprises only 10 years (and the small number of observations limits the number of explanatory variables that can be included in the equation), other, more gradual causes of a change in per capita consumption, such as the Surgeon General's reports, anti-smoking publicity or demographic changes, are not specified separately from the trend variable. Thus, for instance, birth cohort effects are not assigned a separate variable because it is assumed that the decrease in per capita cigarette consumption caused by deaths in the age groups of heavy smokers born between 1910 and 1930 would not have an effect significantly above trend for a study period of only ten years.

The scenarios ranged from the assumption of a TEMPORARY change in the intercept or the slope of the trend line to the assumption of a PERMANENT change in the intercept and the slope. The dummy variable was coded as 1 for the years showing a sharp decline in consumption and as 0 for the remaining years.

The regression equation that resulted in the best fit for the trend line is based on a permanent change both in the intercept and the slope of the trend line and produced the following estimates:

Table 4.6 Equations Used to Compute Immediate Impacts of the Supply and Demand Model

1. Tobacco Farming Revenue:

$$ER_t = EQ_t + EP_{td} + EP_{td}EQ_t$$

2. Tobacco Quota Lease Rate:

$$EL = (1/\alpha_L)[EP_{td} - (1 - \alpha_L)\mu EQ_t]$$

3. Tobacco Quota Lease Revenue:

$$ER_L = EL + EQ_t + EQ_tEL$$

4. Tobacco Producers' Surplus:

$$EPS_t = \mu EQ_t(1 + EQ_t/2)(1 - \alpha_L)P_{td}Q_t$$

5. Cigarette Company Revenue Net of Excise Taxes:

$$ER_c = \beta_{cd}(EQ_{cd} + \gamma EP_{cd} + \gamma EQ_{cd}EP_{cd}) + (1 - \beta_{cd})(EQ_{ce} + EP_{ce} + EQ_{ce}EP_{ce})$$

6. Federal Excise Tax Revenue:

$$ER_T = EQ_{cd}$$

7. Cigarette Consumers' Surplus:

$$ECS_c = 1/2\ P_{cd}Q_{cd}[EQ_{cd}/\eta_{cd} - EP_{cd}(1 + EQ_{cd})]$$

[15] *Kenneth E. Warner, The Effects of the Anti-Smoking Campaign on Cigarette Consumption, American Journal of Public Health (July 1977) vol. 67, no. 7, pp. 646-650.*

Percapcon = 3731.88 −

31.92(YEAR) + 281.79(DUMMY) − 55.98(YEAR)(DUMMY)
(−3.61) (2.20) (−2.99)

where Percapcon stands for per capita cigarette consumption. The standard error for this estimation was ±36.95 with an R^2 of .70. The t-statistic (in parentheses) was significant, with 6 degrees of freedom, at a 90% confidence interval for the intercept parameter and at a 95% confidence interval for the remaining parameters.

The scenario underlying this equation assumes that over the next ten years the trend in cigarette consumption will continue to follow the pattern established in 1982. This implies that in the coming decade per capita cigarette consumption will further decline if factors contributing to this trend remain the same over the next ten years, factors such as cigarette pricing, attitudes toward smoking, anti-smoking laws, and cohort effects.[16]

The estimates arrived at by this method and shown in table 4.7 indicate a 27.6 percent decrease in per capita cigarette consumption, i.e. from 3,241.04 (162 packs) in 1985 to 2,343.57 (117.2 packs) in 1995. When the estimated per capita figures are multiplied by the population projections for the years 1985 to 1995, the results show an estimated decrease in total cigarette consumption of 21.6 percent, i.e. from 593.14 billion in 1985 to 465.58 billion cigarettes in 1995. Both the per capita and the total consumption reductions are in line with the projections discussed in *Tobacco Situation* and *U.S. Industrial Outlook 1985*, with the former predicting a per capita decline of 10 to 25 percent by 1990[17] and the latter predicting a possible decrease in total consumption of as much as 2 to 3 percent annually.[18]

4.2.3 Fire Loss Impact Model and Linkage to the Supply and Demand Model

Given the baseline data on fire losses per billion cigarettes and cigarette consumption, a model needs to be developed to compute the loss impacts. The fire loss impacts have to take into account both the direct effect of the change in the probability of ignition expected from the cigarette modification, as well as the indirect effect from a change in consumption caused by cost and price changes. The model must permit these direct and indirect effects to occur simultaneously so that their interaction can be correctly measured. The fire loss impact model must also be compatible with the supply and demand model so that the cigarette consumption effects from the model can be included.

The following computational equation for a single fire loss category and a particular cigarette modification satisfies the above modeling requirements:

$$D_y = -(EQ_{cd} + EI + EQ_{cd}\,EI)\,Q_{cd,y}\,DPC_y,$$

where D_y = fire loss reduction in year y for the damage category and modification,

EQ_{cd} = proportional change in domestic cigarette consumption as computed by the supply and demand model,

EI = proportional change in the ignition probability due to the modification,

$Q_{cd,y}$ = projected domestic cigarette consumption for year y, and

DPC_y = projected fire loss per cigarette in year y for the damage category.

The third term within the parentheses accounts for the interactive effects between the two proportional changes. The data that were used with this computational equation in the impact analyses are presented in section 5.

4.3 Health Impact Model

The following adverse health effects have been attributed by the Surgeon General to cigarette smoking: (1) shortened life, (2) medical costs for the treatment of smoking-related diseases, (3) complications of pregnancy, (4) productivity losses, and (5) reduced quality of life.[19]

In this section, a model is presented that estimates changes in the first two of these health effects as generated by modification-induced changes in cigarette consumption and cigarette potency. Changes in consumption are caused by changes in cigarette supply and demand attributed to the modification. Potency changes are driven by changes in the chemical composition of the modified cigarette.

4.3.1 Data Considerations

Health Data. A constraint in developing any working model is the nature of available data. For estimating the health costs of smoking, there are two basic approaches: (1) prevalence-based, and (2) incidence-based. The prevalence-based approach assigns health costs to the years in which they are incurred, whereas the incidence-based approach assigns the stream of health costs to the year in which the

[16] *See also Robert H. Miller, "The Domestic Tobacco Market - A look Ahead Through the 1980's," Tobacco Situation, Economics, Statistics, and Cooperatives Service, U.S. Dept. of Agriculture, TS-171 (March 1980, p. 32.*

[17] *Miller, "The Domestic Tobacco Market, p. 32.*

[18] *1985 Industrial Outlook, Section 43, "Tobacco," Bureau of Industrial Economics, U.S. Department of Commerce, pp. 43-45.*

[19] *U.S. Dept of Health and Human Services, Reports of the Surgeon General, 1982, 1983, 1984, 1986.*

illness first appears. As noted in Hartunian *et al*,[20]

Whether the prevalence or the incidence methodology is the more relevant depends on the issues at stake. For decision makers concerned with controlling current medical costs and absenteeism, the prevalence approach is superior. For decision makers evaluating preventive and ameliorative programs, the prevalence approach is misleading, inasmuch as it largely focuses on the current costs of conditions that commenced in the past and that present preventive programs cannot affect.

The annual value of a disease vaccination program — say, for polio — not benefiting previous disease victims is best calculated following the incidence approach. In contrast, the benefits of a program improving the functioning of afflicted individuals — some of whom acquired the condition years earlier — would best be valued according to the prevalence approach.

Inasmuch as a modification-induced change in cigarette consumption may affect the future costs of persons currently disease-free, rather than the current costs among the ill, the incidence-based approach is likely to be the preferred approach. Health data from the incidence-based approach typically consist of estimates, for selected discount rates, of the changes in present value lifetime health care costs and in years of life expectancy per person by age and sex which are estimated to result from smoking at (and quitting from) specified levels of cigarette consumption.

[20] *N.S. Hartunian, C.N. Smart, and M.S. Thompson, "The Incidence and Economic Costs of Cancer, Motor Vehicle Injuries, Coronary Heart Disease, and Stroke: A Comparative Analysis," American Journal of Public Health, vol. 70, no. 12 (December 1980) pp. 1249-1260.*

Table 4.7 Actual and Projected Total and Per Capita Consumption of Cigarettes

Year	Cigarette Consumption (in billions)	Resident Population (16 yrs. and over) (in thousands)	Per Capita Cigarette Consumption
		Actual Cigarette Consumption	
1976	598.91	159,847	3,746.77
1977	603.88	162,898	3,707.10
1978	604.82	165,932	3,644.99
1979	612.04	168,952	3,622.57
1980	618.57	171,953	3,597.32
1981	627.15	174,516	3,593.65
1982	624.01	176,822	3,529.03
1983	596.19	178,966	3,331.30
1984	600.17	180,979	3,316.24
1985	593.14	183,009	3,241.04
		Projected Cigarette Consumption	
1986	578.66	184,569.6	3,134.67
1987	568.62	186,631.6	3,046.77
1988	557.22	188,323.6	2,958.87
1989	545.14	189,879.6	2,870.97
1990	532.39	191,294.6	2,783.07
1991	519.54	192,766.6	2,695.17
1992	506.23	194,160.6	2,607.27
1993	492.90	195.643.6	2,519.37
1994	479.23	197,095.6	2,431.47
1995	465.58	198,664.6	2,343.57

DATA SOURCES: The figures on total cigarette consumption for the years 1976 to 1985 were taken from The Maxwell Report, *Year-end Sales Estimates for the Cigarette Industry*, by Maxwell Associates, A Division of Furman, Selz, Mager, Dietz & Birney, Inc., New York. The data on U.S. resident population came from the *Current Population Reports, Series P-25, Nos. 917, 952, and 985*, U.S. Department of Commerce, Bureau of the Census.

Smoking Demographics Data. A method was needed for combining the disaggregated health data which are age, sex, and smoking-level specific in order to reflect average health impacts that are properly weighted. The most comprehensive data source on U.S. smoking behavior is the National Health Interview Survey conducted by the National Center for Health Statistics.[21] From the National Health Interview Survey results, data can be compiled on the numbers of smokers by age, sex, and smoking level consistent with the age groups and smoking-level categories defined by the available health data.

Price Elasticity of Demand Data. An essential ingredient in estimating health impacts of cigarette modifications is predicting how consumers will respond to the modified cigarette. Numerous studies have predicted consumer response to a change in the price of cigarettes through estimating the "price elasticity of demand" for cigarettes. The most reliable estimates of cigarette price elasticity to date appear in the 1982 study by Lewit and Coate.[22] The health, smoking demographics, and elasticity data used in the health impact model are presented in section 5.1.3.

4.3.2 Requirements of the Model

Accommodate Consumption Changes of any Magnitude. A method was needed for arriving at the health impacts of a variety of cigarette modifications. Each cigarette modification may lead to a different change in cigarette consumption. Thus, in order to accommodate any possible change in cigarette consumption, health impacts have to be determined on a per cigarette basis. In that way, per cigarette health impacts can be applied to a change in cigarette consumption of any magnitude.

Accommodate Consumption Increases and Decreases. While one cigarette modification might be estimated to increase cigarette consumption, another might be estimated to decrease consumption. Since health impacts are assumed to be asymmetric, the model has to be capable of estimating health impacts separately for both increases and decreases in cigarette consumption.

Include Health Impacts Over the Study Period. Some health effects can be modeled as instantaneous. For people in younger age groups, however, measurable health effects of changes in smoking behavior may be delayed beyond the time the modification is implemented. These delayed health effects need to be phased in over the study period.

Accommodate Alternative Discount Rates. Because of uncertainty concerning the appropriate discount rate, it is desirable that the model be able to accommodate alternative discount rates.

Accommodate Implementation Lag. In order to assess the effect of delaying implementation of the cigarette modifications, the model has to be capable of estimating health impacts for cigarette modifications taking effect at different points in the study period.

4.3.3 Eight-Step Modeling Procedure

In this section, the health impact model is described as an eight-step procedure. The first four steps form the core of the model and were developed for estimating instantaneous health impacts due to a cigarette consumption decrease occurring at the beginning of the study period and evaluated at a zero discount rate. The last four steps integrate desired features into the model, including the phasing in of health impacts over the study period, and the changes made to estimate health impacts for consumption increases, for the implementation lag, and for a positive discount rate. For a complete listing of all equations comprising the health impact model, see appendix B.

STEP 1: Model the Elasticity Data

A cigarette modification may change the quantity of cigarettes smoked in two ways: (1) by changing smoking status (i.e., whether or not a person smokes), called the "participation effect," and (2) by changing cigarette consumption levels (i.e., how much a smoker smokes), called the "consumption effect." The participation effect is expressed in terms of numbers of people changing smoking status, and the consumption effect in terms of numbers of cigarettes smoked by smokers. In order to properly account for both effects, "quantity shares" were estimated, indicating in percent form what portion of the total change in cigarettes is accounted for by the participation effect, and what portion by the consumption effect. That is, the quantity shares give the relative contributions of the participation and consumption effects to changes in total cigarette consumption.

Two estimates of the price elasticity of demand for cigarettes were used to determine quantity shares:

(1) A "total" price elasticity, giving the overall consumer response to price changes, denominated in numbers of cigarettes; and

(2) A "participation" price elasticity, giving that portion of the overall response attributable to changes in smoking status, denominated in numbers of people.

The quantity share value for the participation effect was estimated by taking the ratio of the number of cigarettes accounted for by the participation effect to the total change in cigarette consumption. The cigarettes accounted for by the participation effect were determined by (1) applying the participation price elasticity to the number of smokers, giving

[21] *U.S. Dept. of Health and Human Services. PHS, NCHS, Provisional Data form the Health Promotion and Disease Prevention Supplement to the National Health Interview Survey: United States, January-March 1985, Hyattsville, MD, November 1985.*

[22] *Eugene M. Lewit and Douglas Coate, "The Potential for Using Excise Taxes to Reduce Smoking," Journal of Health Economics, no. 1 (1982), pp. 121-145.*

the number of people changing smoking status per percentage price change, and then (2) converting people changing smoking status to numbers of cigarettes by applying the average number of cigarettes "smoked" per day by a person changing smoking status (an average of cigarettes per day per smoker and former cigarettes per day per quitter). The total change in cigarette consumption per percentage price change was simply the total price elasticity times the total daily cigarette consumption. The resulting quantity share expresses the proportion of the change in the total number of cigarettes smoked accounted for by the participation effect. The quantity share value for the consumption effect is then determined as the residual proportion.

Modified cigarettes may affect consumer demand through changes in both cigarette price and in taste and other smoking attributes. Consumption changes induced by taste and other smoking attributes are also expected to have participation and consumption effects. In the absence of specific estimates of consumer response to changes in cigarette taste and other attributes, the quantity shares described above were used to apportion the consumer response to taste and other smoking attribute changes between the participation and consumption effects.

STEP 2: Model the Health Data

Participation Effect. The participation effect is defined as changes in cigarette consumption due to changes in smoking status. In the case of a decrease in cigarette consumption, two sources could cause smoking status to be different from what it otherwise would be. Current smokers might quit (quitters), and nonsmokers who otherwise would have begun smoking might not start (non-starters). Because most non-starters are found in the younger age groups and most databases do not report measurable effects for these smokers, the health-related participation effect for a decrease in cigarette consumption should be based mainly on current smokers quitting.

Consumption Effect. The consumption effect is defined as a change in the number of cigarettes smoked by smokers. For a decrease in cigarette consumption, health data on the benefits of quitting can be used to determine the value gained by smokers lowering their consumption levels. Specifically, in order to assign health impacts to reductions in numbers of cigarettes smoked, dose-response curves should be drawn using quitting benefits data, showing how health impacts change as cigarette consumption decreases.[23]

If health data distinguish among smoking levels, then average consumption levels should be computed for each level. Dose-response curves can then be drawn by interpolation between each average consumption level. Once dose-response curves are developed, slopes can be computed, representing the health impacts per unit change in cigarette consumption.

[23]*G. Oster, G.A. Colditz, and N.L. Kelly, "The Economic Costs of Smoking and Benefits of Quitting for Individual Smokers," Preventive Medicine, no. 13 (1984) pp. 377-389.*

STEP 3: Model the Smoking Demographics Data

The disaggregated health impacts developed in Step 2 had to be combined to reflect weighted averages. This was done by applying to the health impacts a system of weights, based on current smoker demographics. Specifically, the age, sex, and smoking-level specific health impacts were weighted by the relative frequency of smokers of the corresponding age groups, sexes, and smoking levels. The sum of these weighted health impacts across all age groups, sexes, and smoking levels provided the weighted average health impact.

Use of this weighting system for the participation effect assumes that quitters change their smoking status in the same age, sex, and level proportions as smokers currently smoke. One might speculate, however, that levels from which smokers quit are substantially lower than levels at which current smokers smoke, rendering the above assumption quite restrictive. Analysis of the smoker demographics data, however, revealed that, in 1985, smokers smoked on average 20.87 cigarettes per day, and in 1983 (the latest year for which these data were available), smokers who quit smoking between 1978 and 1983 quit from an average 22.95 cigarette-per-day habit. The small disparity in these numbers supports using current smoker demographics to create a weighting system for generating average health impacts.

STEP 4: Combine the Quantity Shares and Weighted Average Health Impacts

Steps 1-3 yield the following: (1) two quantity share values, indicating the relative proportions of the change in the total number of cigarettes smoked accounted for by the participation and consumption effects, (2) for the participation effect, weighted average per capita health impacts from changing smoking status, in dollars and life-years, and (3) for the consumption effect, weighted average per cigarette health impacts from changing the number of cigarettes smoked, in dollars and life-years. The next step is to combine the health impacts generated by the participation and consumption effects to arrive at dollar-value and life-year estimates of composite health impacts per cigarette. This is done by converting participation effect health impacts to the same "per cigarette" basis used in the consumption effect, applying each health impact to its corresponding quantity share, and then summing the results.

Participation Effect. Before health impacts can be summed, impacts for the participation effect, expressed on a per capita basis, must be converted to a per cigarette basis. This is done in two steps. First, an average number of cigarettes "claimed" to be smoked per person is applied to the per capita health impacts. These cigarettes are "claimed" to be smoked in the sense that they are based on smoker survey data. Comparisons of survey data with cigarette sales data indicate that smokers significantly underreport cigarette consumption. The second step, then, was to apply an "underreporting adjustment" to convert participation effect health impacts from a per "claimed" cigarette basis to a per "actual" cigarette basis.

The participation effect health impacts, now on a per cigarette basis, are next scaled down by the participation effect

quantity share. The result is an estimate of the portion of total health impacts per cigarette accounted for by the participation effect.

Consumption Effect. The weighted average health impacts from the consumption effect are already expressed on a per cigarette basis. Once scaled down by the consumption effect quantity share, they represent the portion of total health impacts per cigarette accounted for by the consumption effect.

The sum of the participation and consumption effect health impacts, each scaled down by their respective quantity share, represents total instantaneous health impacts per cigarette.

STEP 5: Include Health Impacts Over the Study Period
The above four steps for evaluating health impacts from cigarette modifications assigns instantaneous impacts only. That is, impacts are assigned only for those age groups having measurable health effects at the time the cigarette modification is implemented. Over the study period, however, younger persons will reach ages at which the health risks of smoking are measured by most databases. To incorporate these delayed health effects for younger age groups into the model, Step 2 was modified.

In Step 2, the health data used to value both the participation and consumption effects for younger ages were limited to the costs of smoking only. Smoking cost data differ from quitting benefit data because the health risk of smoking is not eliminated immediately upon quitting. Since existing databases do not report substantial health risk from smoking at these younger ages, quitting benefits for this age group should be equal in amount to smoking costs. For the participation effect, then, smoking cost data apply, and for the consumption effect, smoking cost dose-response curve data apply.

It is important to note that the length of the study period sets the age limit for assigning health impacts. Younger age groups have been found to deliver a much larger price response than older age groups. Any change in cigarette prices could, in the long run, have the greatest impact on the youngest generation. These impacts could be taken into account by extending the study period.

STEP 6: Modify Model for the Four-Year Lag
To accommodate the requirements of the case studies of section 5, the model must be modified to assume that the cigarette modification takes effect in the fourth year of the study period. Since, over four years, some of the younger ages will have become subject to the measured health risks of smoking, they must be assigned instantaneous health impacts in year four.[24]

STEP 7: Modify Model for Alternative Discount Rates
Two changes must be made to incorporate alternative discount rates. First, the basic health data used must be based on the desired discount rate. Second, appropriate single present worth discount factors must be added to the health impact model to discount health impacts occurring over the study period.

STEP 8. Modify the Consumption Effect if Consumption Increases
For increases in cigarette consumption, health impacts due to the consumption effect should be valued using *smoking cost* dose-response curve slopes for *increases* in consumption levels, as opposed to *quitting* benefit dose-response curve slopes for *decreases* in consumption.

4.3.5 Linkage to the Supply and Demand Model

Once the health impact model is run, its results need to be linked to the supply and demand model. That is, the health impact model gives intermediate values that are used in conjunction with the supply and demand model to estimate aggregate health impacts. To generate aggregate health impacts for the entire United States, these intermediate "per cigarette" health impacts are applied to the portion of the modification-induced change in cigarette consumption subject to health impacts. This change in cigarette consumption is based on three values: (1) total U.S. average daily cigarette consumption, (2) the modification-induced proportional change in U.S. cigarette consumption, and (3) the proportion of U.S. cigarette consumption subject to health impacts.

Total U.S. Average Daily Cigarette Consumption. The annual rates projected for baseline cigarette consumption over the 10-year study period indicate how cigarette consumption might change over the next 10 years in the absence of any modification to the cigarette. An average of these annual rates of consumption was taken to approximate the number of cigarettes subject to modification-induced change per year over the 10-year study period. A 10-year average was taken for the analysis assuming no lag in implementing the modification, and an average of the six years 1990 through 1995 was taken for the 4-year lag analysis.

Proportional Change in U.S. Cigarette Consumption. The proportional change in U.S. cigarette consumption was that generated by the supply and demand model for the cigarette modification case scenario under analysis.

Proportion of U.S. Cigarette Consumption Subject to Health Impacts. The cigarette modification generates a change in cigarette consumption, not all of which is subject to health impacts. The share of total U.S. cigarette consumption smoked by those ages subject to the measured health risks of smoking over the study period represents the proportion of consumption subject to health impacts.

The equations for computing aggregate health impacts are as follows:

[24] *The approach taken in the four-year lag analysis uses the same smoking demographics data discussed in Step 3.*

$A\$_i$ $H\$_i$ $(Q_{cd}/365)$ EQ_{cd} RS, and

AY_i $= HY_i$ $(Q_{cd}/365)$ EQ_{cd} RS,

where $A\$_i$ = aggregate U.S. health impacts, in dollars of health care costs, for discount rate i,

AY_i = aggregate U.S. health impacts, in years of life-expectancy, for discount rate i,

$H\$_i$ = dollar-value health impacts per cigarette "at risk" per day, for discount rate i,

HY_i = life-year health impacts per cigarette "at risk" per day, for discount rate i,

Q_{cd} = total U.S. annual average cigarette consumption,

365 = days per year, for converting annual cigarette consumption to daily cigarette consumption,

EQ_{cd} = proportional change in U.S. cigarette consumption, and

RS = proportion of U.S. cigarette consumption subject to health impacts.

Adjusting Health Impacts for Changes in Tar, Nicotine, and CO Content. The aggregate health impacts detailed above are based only on changes in cigarette consumption resulting from modification-induced changes in cigarette price, taste and other smoking attributes. If the cigarette modification also changes tar, nicotine, and CO content, then health impacts might be affected. A cigarette potency adjustment can be added to the equations above for estimating aggregate health impacts given changes in tar, nicotine, and CO content, but the effect of changes in cigarette chemical composition on health care costs and life expectancies is not clear. It may be assumed that health care costs and life expectancies change in some proportion to cigarette chemical composition. If this relationship can be specified as proportional, the equations above for computing aggregate health impacts can be modified as follows:

Replace EQ_{cd} with $[EQ_{cd} + p\ EN(1 + EQ_{cd})]$,

where p = the proportion of health care costs and life expectancies attributable to tar, nicotine, and CO, and

EN = the proportional change in tar, nicotine, and CO content.

4.4 Employment Impacts

Estimation of the employment effects of the cigarette modifications requires several types of data and an impact model that is linked to the supply and demand model.

4.4.1 Data Requirements for Employment Impacts

There are three types of data needed to estimate employment impacts. First, data are needed on the baseline levels of employment in each of the economic sectors expected to be significantly affected by the cigarette modifications. These sectors are tobacco farming, cigarette manufacturing, tobacco warehousing, non-tobacco cigarette support industries such as paper and energy, cigarette wholesaling, and cigarette retailing. Second, data are required on the direct employment impacts expected from each of the modifications. Direct impacts in this context refer to those that result immediately from changes in the production process without taking into account possible changes in the levels of tobacco and cigarette production. These data must be collected by interviews and analysis of how the modifications might affect the production process. Third, data are needed for each economic sector on the elasticities of employment with respect to levels of production. For example, it must be known by what percent employment in cigarette wholesaling is expected to change for every one percent change in cigarette production. The employment data used in selected impact analyses are presented in section 5.

4.4.2 Employment Impact Model and Linkage to the Supply and Demand Model

The employment impact model must compute the direct and the indirect impacts for each of the cigarette modifications and each of the economic sectors affected. The following equation permits such computation for a particular modification and is linked to the results of the supply and demand model:

$$W_i = DI_i + \eta_i N_i EQ_i,$$

where W_i = employment impact for the ith economic sector,

DI_i = direct employment impact for the ith economic sector,

η_i = elasticity of employment for the ith economic sector,

N_i = baseline employment in the ith economic sector, and

EQ_i = proportional change in the production level of the commodity relevant to the ith economic sector.

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5. Impact Analysis Results for Five Hypothetical Cigarette Design Modifications

This section describes the results of the impact analyses that were conducted for each of the five cigarette design modifications described in section 2: (1) reduced cigarette circumference from 25 mm to 21 mm; (2) increased use of expanded tobacco; (3) chemical additive to the tobacco blend; (4) increased paper weight from 24 to 32 grams per square meter; and (5) decreased paper porosity from 35 to 10 Coresta units. For each modification, six impact analyses were carried out. The six analyses resulted from the sensitivity analysis with respect to two variables: shift in demand due to the modification; and the date of implementation. Three alternative assumptions regarding possible shifts in demand due to changes in the taste or other performance characteristics of the cigarettes were made: (1) no change; (2) five percent increase; and (3) five percent decrease. Two alternative assumptions were made with respect to the date of implementation: (1) immediate implementation as of January 1, 1986; and (2) delayed implementation until January 1, 1990 with four years advance warning. Combining the demand shift and the implementation alternatives results in six cases for each of the five cigarette modifications.

Section 5.1 summarizes the input data used in the impact analyses. Then a sample impact analysis report is presented and its format explained in section 5.2. Next, impact analysis results for each of the five cigarette design modifications are summarized and discussed in turn in section 5.3. The section concludes with a discussion of the sensitivity of results to key assumptions and a summary of findings.

5.1 Data Used in the Impact Analyses

As indicated in section 4, the application of the economic impact model requires a variety of data elements. This subsection discusses the actual data that were used in conducting the impact analyses. First, the consultants who provided supporting data are listed and their principal areas of contribution are identified. Second, the data used by the supply and demand model are presented. Then, the data used in the fire loss model, the health effects model, and the employment model are presented.

5.1.1 Supporting Data Studies

The impact analyses required data from a number of specialized subject areas. To help meet the extensive data requirements, the Technical Study Group arranged for consultants, under separate contracts, to perform supporting studies. These supporting studies are included in Volumes 5 and 6 of the Technical Study Group reports, and are a major source of data used in this report. The data are used in the impact analysis at the direction of the Technical Study Group; their accuracy have not been verified by the National Bureau of Standards. Below is a listing of these consultants, their respective areas of contribution, report titles, and volume of the Technical Study Group reports in which the work appears:

Fire Statistics — Dr. John Hall, Jr., "Expected Changes in Fire Damages from Reducing Cigarette Ignition Propensity," Volume 5, Technical Study Group Reports.

Health Statistics — Dr. Gerry Oster, "Estimates of the Economic and Noneconomic Health Consequences of Smoking, Smoking Cessation, and Reduction in the Amount Smoked," Volume 6, Technical Study Group Reports.

Industry Cost Data — Dr. Armando Lago, "Cost Analysis of Options for Self-Extinguishing Cigarettes," Volume 6, Technical Study Group Reports.

Agricultural Data — Dr. Daniel Sumner, "The Impact of Cigarette Modifications on the Tobacco Production Industry in the United States," Volume 6, Technical Study Group Reports.

Consumer Response — Dr. Gary Ford and Dr. John Brown, "The Costs and Benefits to Smokers of Reduced Flammability Cigarettes," Volume 6, Technical Study Group Reports.

Employment Data — Dr. David Greenberg, "The Employment Implications of Proposed Cigarette Design Modifications to Reduce Cigarette Ignition Propensity," Volume 6, Technical Study Group Reports.

It is indicated in the text following when data is drawn from one of these supporting studies. The reader is referred to

these sources for information about the data beyond that provided in this report.

5.1.2 Data Used to Solve the Supply and Demand Model

The first category of data needed to solve the supply and demand model consists of the values used for the model parameters. Table 5.1 presents the most likely range and the value within the range that has been used for each of the parameters. The data for all but the last parameter are drawn from the supporting study on agricultural data.[25] The share of modification costs not included in exported cigarettes was set at 1.0 at the direction of the Technical Study Group. This is equivalent to assuming that the envisioned cigarette modifications would be required *only* for cigarettes sold in the United States, and that separate production facilities could be dedicated to cigarettes destined for the export market.

The next data category for the supply and demand model focuses on the proportional changes in each of the exogenous variables. Since no reliable estimates are available for the exogenous variable specifying shifts in demand that may result from the modifications, the Technical Study Group recommended that the impact analyses be conducted for no change in exported cigarettes and for three alternative changes in the demand for domestic cigarettes: no change, five percent increase, and five percent decrease. For the three remaining exogenous variables, the values used in the impact analyses for four of the cigarette modifications are drawn from the supporting study on industry cost data.[26] The cost data for the modification of decreasing the paper porosity are based on discussions with a representative of a major cigarette paper manufacturer, who indicated that decreasing paper porosity would likely have little impact on paper costs, and that the direction of change could be either up or down.[27] The data for all five modifications are presented in percentage change form in table 5.2.

The third type of data needed for the supply and demand model concerns the baseline values for the endogenous variables. For example, the total number of cigarettes and pounds of tobacco produced, and the current prices of cigarettes and tobacco are needed. These are needed to determine the absolute changes in prices and quantities (in addition to the proportional or percentage changes). The initial or baseline values used for the endogenous variables in the impact analyses are presented in table 5.3 and are drawn from the supporting study on agricultural data, as well as from the cigarette industry report called the *Maxwell Report*.

[25] *Daniel A. Sumner, "The Impact of Cigarette Modifications on the Tobacco Production Industry in the United States," Report No. 6, Technical Study Group, table 3.*

[26] *Armando M. Lago, and Jennifer A. Shannon, "Cost Analysis of Options for Self-Extinguishing Cigarettes," Report No. 6, Technical Study Group.*

[27] *Clifford M. Kaufman, Ecusta Corporation, Pisgah Forest, NC, Interview in Washington, D.C., July 1987.*

5.1.3 Fire Loss Data

The baseline fire loss data that are used in the impact analyses are presented in table 5.4. These are taken from the supporting study on fire statistics.[28]

5.1.4 Health Impact Data

As noted in section 4.3, health data estimated using an incidence-based approach are best suited to the purposes of this study. According to Shultz,[29] "An analytical study by Oster and colleagues . . . represents the most sophisticated application of this [incidence-based] methodology to the costs of cigarette smoking." Dr. Oster's health data, summarized in the supporting study of health data, consist of changes in years of life expectancy and in medical care costs for the treatment of the three major diseases causally linked to smoking: (1) lung cancer, (2) coronary heart disease, and (3) chronic obstructive pulmonary disease. These data, presented in tables 5.5 and 5.6, were used in developing dose-response curves expressing health impacts as a function of cigarette consumption.[30]

A limitation of these health data is that they are largely based on studies done in the 1950's and 1960's. Because the duration of smoking for both men and women at this time was shorter than the duration of smoking for the current population, the health data derived from these earlier studies may be conservative estimates of actual health impacts today.

Elasticity Data. The elasticity data used for estimating health impacts[31] are as follows:

Total Retail Price Elasticity of Demand for Cigarettes:	−0.42
Participation Retail Price Elasticity of Demand for Cigarettes:	−0.26

These retail elasticity values are based on the smoking behavior of 20-74 year-olds. Both were found to be statistically significant at a 5% confidence interval on a two-tailed test.

[28] *John R. Hall, Jr., "Expected Changes in Fire Damages from Reducing Cigarette Ignition Propensity," Report No. 5, Technical Study Group.*

[29] *J.M. Shultz, "Perspectives on the Economic Magnitude of Cigarette Smoking," New York State Journal of Medicine (July 1985), pp. 302-306.*

[30] *Gerry Oster, "Estimates of the Economic and Noneconomic Health Consequences of Smoking, Smoking Cessation and Reductions in the Amount Smoked," Report No. 6. Technical Study Group. This report was based on earlier work reported in Oster, Colditz, and Kelly, "The Economic Costs of Smoking and Benefits of Quitting for Individual Smokers," Preventive Medicine, no. 13 (1984) pp. 377-389 and Oster, Huse, Delea, and Colditz, "Cost-Effectiveness of Nicotine Gum as an Adjunct to Physician's Advice Against Cigarette Smoking," Journal of the American Medical Association, no. 256 (1986) pp. 1315-1318.*

[31] *Lewit and Coate, "The Potential for Using Excise Taxes to Reduce Smoking," p. 135.*

Smoking Demographics Data. Smoking demographics data were computed using raw data compiled in the National Health Interview Survey conducted in 1985 by the National Center for Health Statistics. Table 5.7 presents the data computed for the number of smokers consistent with the five-year age groups and the three smoking-level categories used in the health data.

Several other values were computed from the Health Interview Survey data for use in the health impact model. They are as follows:

Total Cigarettes Smoked Per Day, Ages 18-24:	128,128,461
Total Cigarettes Smoked Per Day, Ages 25-34:	274,758,659
Total Cigarettes Smoked Per Day, Ages 35-79:	628,525,665
Total Cigarettes Smoked Per Day, Ages 80+:	8,084,852
Average Cigarettes Smoked Per Day Per Smoker:	20.87
Average Cigarettes Formerly Smoked Per Day Per Quitter:[32]	22.95
Average Cigarettes Smoked Per Day, Light Smokers:	9.50
Average Cigarettes Smoked Per Day, Moderate Smokers:	23.02
Average Cigarettes Smoked Per Day, Heavy Smokers:	44.23
Proportion of U.S. Cigarette Consumption Subject to Health Impacts:[33]	0.83

Note that the values listed above for average cigarettes smoked per day by light, moderate, and heavy smokers were used as midpoints for developing dose-response curves.

Data for Step 4, Combining the Quantity Shares and Weighted Average Health Impacts. Participation effect health impacts were converted to a per cigarette basis by applying an "underreporting adjustment." This accounts for the fact that smokers smoke more cigarettes per day than they claim. The value used for the underreporting adjustment was 0.67. This value is the ratio of "claimed" versus "actual" total daily cigarette consumption. Claimed cigarette consumption for all smokers (ages 12+) was the sum of the

[32] *This value is based on data from the 1983 National Health Interview Survey.*

[33] *This value is the ratio of total cigarette consumption for ages 25-79 versus total cigarette consumption for all ages (ages 12+).*

Table 5.1 Definitions, Range, and Values of Parameters Used in the Supply and Demand Model

Symbol	Definition	Range	Value Used
η_{cd}	Wholesale price elasticity of domestic demand for cigarettes	0.2 - 0.5	0.3
η_{ce}	Wholesale price elasticity of export demand for cigarettes	1.0 - 5.0	3.0
η_{td}	Derived demand elasticity for domestic tobacco	0.5 - 1.5	1.0
η_{te}	Price elasticity of export demand for tobacco	1.0 - 5.0	2.0
α_{td}	Cost share of domestic tobacco in cigarettes	0.05 - 0.10	0.07
α_K	Cost share of paper in cigarettes	0.003 - 0.010	0.005
α_T	Cost share of Federal excise tax in cigarettes	0.20 - 0.25	0.237
α_L	Cost share of lease rates in tobacco production	0.10 - 0.30	0.15
β_{cd}	Quantity share of U.S. cigarettes in domestic market	0.85 - 0.90	0.9
β_{td}	Quantity share of U.S. tobacco in U.S. cigarettes	0.5 - 0.7	0.6
μ	Elasticity of marginal cost of tobacco	0.1 - 0.4	0.2
ε	Agricultural policy response elasticity for tobacco	0.0 - ∞	1.0
θ	Share of modification costs not included in exported cigarettes	0.0 - 1.0	1.0

Source: D. A. Sumner, "The Impact of Cigarette Modifications on the Tobacco Production Industry in the United States," Report No. 6, Technical Study Group, Table 3, January 1987.

Table 5.2 Percentage Changes in Tobacco Content, Paper Costs, and Other Costs for Selected Cigarette Modifications.

Cigarette Modification	Percent Change		
	Tobacco Content	Paper Costs	Other Costs
Decrease Circumference from 25 to 21 mm	−29.4	−16.0	+1.40
Increase Percentage of Expanded Tobacco	−12.73	0	−0.58
Increase Paper Weight from 24 to 32 g/m²	0	48.2	0.3
Decrease Paper Porosity[2] from 35 to 10 Coresta	0	0	0
Add Chemical to Tobacco Blend	0	0	2.83

(1) Data based on informal discussions with Dr. C. M. Kaufman, Ecusta Corporation, Pisgah Forest, NC, July 1987.

SOURCE: A. M. Lago and J. A. Shannon, "Cost Analysis of Options for Self-Extinguishing Cigarettes," *Report No. 6.*

total cigarette consumption figures listed above for ages 18+ and an estimate of total cigarette consumption by 12-17 year-olds of 52,328,767 cigarettes per day.[34] Actual cigarette consumption was the daily equivalent of the 1985 total cigarette consumption figure [1,625,041,100 (=593.14 bill./365)] from *The Maxwell Report* listed in table 4.7.

Data from the Health Impact Model. The health impact model described in section 4.3 was run using the above data. Table 5.8 presents the results.

5.1.5 Employment Data

All three categories of the employment data used in the impact analyses are presented in table 5.9. The baseline employment levels and the direct employment effects for each of the six sectors are given in terms of full-time equivalent jobs. The direct effect on the cigarette manufacturing sector for the circumference modification is the product of the proportional change in the tobacco content per cigarette times the number of jobs directly associated with tobacco handling and preparation in the cigarette manufacturing plants (i.e., 6000 full-time equivalent jobs). The elasticities of employment with respect to levels of production are presented at the bottom of the table, along with the proportional change variable from the supply and demand model that is applicable to each elasticity. These data are drawn from the supporting study on employment data.[35]

5.2 Format of the Impact Analysis Reports

An example of the impact analysis reports is given in table 5.10. The report consists of a single page that contains a description of the modification, a statement of the assumptions of the case, and detailed numerical estimates of the changes in the most significant variables expected to be affected by the modification. These variables and their corresponding estimated changes are grouped into six major impact categories, the first being principal, or first-order, impacts and the remaining five secondary, or second-order impacts:

(1) Fire Damage Impacts,

(2) Tobacco Farming Impacts;

(3) Cigarette Industry Impacts;

(4) Tax & Consumer Impacts;

(5) Health Impacts; and

(6) Employment Impacts.

Note that second-order fire damage impacts are also estimated, but these are small and are combined with the first-order fire damage impacts. The first-order impacts are those that would result from the reduced ignition propensity. The second-order effects (positive or negative) are those that may arise from the changed level of cigarette consumption because of shifts in supply (production costs) and demand (taste). For each of the ten years of the study period, the impacts on three types of fire losses are reported: fire deaths, fire injuries, and property damage from fires. The impact on fire deaths is stated in two ways: the number of lives saved (deaths averted) and the number of years of life expectancy gained. These two ways of stating the fire death impacts should be viewed as alternatives to a single benefit that should not be double counted. Each set of impacts are computed for three alternative assumptions regarding the

[34] *Kenneth E. Warner, "Consumption Impacts of a Change in the Federal Excise Tax," The Cigarette Excise Tax: April 17, 1985, Smoking Behavior and Policy Conference Series, Institute for the Study of Smoking Behavior and Policy, Harvard University (April 17, 1985) p. 95.*

[35] *David Greenberg, "The Employment Implications of Proposed Cigarette Design Modifications to Reduce Cigarette Ignition Propensity," Report No. 6, Technical Study Group.*

Table 5.3 Definitions, Range, and Values of Endogenous Variables Used in the Supply and Demand Model

Symbol	Definition	Units	Range	Value Used
Q_{cd}	Quantity of U.S. cigarettes sold in domestic market	billion/year	560 - 600	583
Q_{ce}	Quantity of U.S. cigarettes sold in export market	billion/year	60 - 80	65
Q_c	Total quantity of U.S. cigarettes produced	billion/year	620 - 680	648
Q_{td}	Quantity of U.S. tobacco sold in domestic market	million lbs/year	800 - 1000	900
Q_{te}	Quantity of U.S. tobacco sold in export market	million lbs/year	500 - 700	600
Q_t	Total quantity of U.S. tobacco produced	million lbs/year	1300 - 1700	1500
P_{cd}	Price of cigarettes sold in domestic market	$/1,000	33 - 36	33.75
P_{ce}	Price of cigarettes sold in export market	$/1,000	25 - 28	25.75
P_{td}	Price of U.S. tobacco sold in domestic market	$/lb	1.40 - 1.60	1.50

Sources: D. A. Sumner, "A Study of the Impact of Cigarette Modifications on the Tobacco Production Industry in the United States," Report No. 6, Technical Study Group.

J. C. Maxwell, Jr., The Maxwell Report; Year-End Sales Estimates for the Cigarette Industry, January 1987.

effectiveness of the modification: 25 percent, 50 percent, and 75 percent reductions in the probability of igniting furniture and mattresses. In addition to the information on impacts for each of the ten years, the results for the entire study period are summarized by computing the present value of each impact series for both a zero discount rate and a five percent rate. The zero discount rate is equivalent to a direct summing of the yearly impacts over the study period.

Note that when a positive discount rate is used on life years, a two-fold discounting process occurs. First, the conversion of each undiscounted life saved to its equivalent number of years of extended life requires that the future added years be discounted to the time of the life saving. Second, each converted life year must then be discounted to the present from the time of occurrence of the saving of the life. Thus, as is apparent from table 5.10, the effect of discounting on the number of life years saved is much greater than on the other fire impact measures.

It is necessary to discount lives and life-years saved, as well as dollars, in order to preserve a consistent relationship between dollars and lives/life-years over time. This is a required procedure for making cost-effective decisions involving expenditures on life-safety programs.

To illustrate the problem that arises from failure to maintain a consistent time relationship between dollars and lives,

Table 5.4 Baseline Data Used to Compute Fire Loss Impacts.

(Per Billion Cigarettes Consumed)

Year	Fires	Deaths	Injuries	Property Loss (Thousand $)
1986	369.2	2.845	12.837	789
1987	356.9	2.816	12.707	798
1988	344.9	2.784	12.581	806
1989	333.8	2.763	12.562	816
1990	322.5	2.734	12.501	823
1991	311.7	2.718	12.492	833
1992	301.4	2.710	12.508	843
1993	291.2	2.699	12.497	852
1994	281.6	2.709	12.562	866
1995	271.7	2.704	12.536	875

SOURCE: John R. Hall, Jr., "Expected Changes in Fire Damages from Reducing Cigarette Ignition Propensity," *Report No. 5*, Technical Study Group.

Table 5.5 Health Date Used in the Health Impact Model: Costs of Smoking

Age/Sex Group	Additional Expected Lifetime Medical Care Costs for the Treatment of Smoking-Related Diseases (1986$)						Reductions in Years of Life Expectancy					
	Discounted at 0 Percent			Discounted at 5 Percent			Discounted at 0 Percent			Discounted at 5 Percent		
	Smoking Level			Smoking Level			Smoking Level			Smoking Level		
	Light	Moderate	Heavy	Light	Moderate	Heavy	Light	Moderate	Heavy	Light	Moderate	Heavy
Men												
35-39	6,305	10,785	16,944	1,332	2,278	3,579	4.69	6.58	8.16	1.01	1.39	1.74
40-44	6,209	10,590	16,502	1,594	2,718	4,236	4.51	6.35	7.88	1.19	1.63	2.03
45-49	6,006	10,167	15,700	1,844	3,122	4,821	4.20	5.96	7.41	1.31	1.83	2.28
50-54	5,612	9,360	14,235	2,014	3,359	5,108	3.77	5.43	6.80	1.38	1.95	2.45
55-59	5,154	8,479	12,727	2,154	3,543	5,318	3.26	4.81	6.07	1.39	2.01	2.55
60-64	4,612	7,483	11,139	2,227	3,614	5,379	2.69	4.10	5.24	1.33	1.98	2.54
65-69	3,980	6,374	9,462	2,180	3,493	5,184	2.07	3.34	4.35	1.17	1.83	2.39
70-74	3,226	5,158	7,684	1,989	3,180	4,738	1.41	2.53	3.40	0.91	1.56	2.10
75-79	2,383	3,798	5,699	1,629	2,596	3,896	0.82	1.77	2.52	0.59	1.21	1.72
Women												
35-39	3,187	5,774	12,063	574	1,039	2,171	2.04	3.89	5.45	0.41	0.70	0.97
40-44	3,138	5,621	11,320	698	1,251	2,519	2.01	3.82	5.34	0.50	0.85	1.17
45-49	3,204	5,745	11,279	859	1,539	3,022	1.87	3.62	5.09	0.56	0.97	1.33
50-54	3,081	5,512	10,832	981	1,755	3,449	1.68	3.36	4.76	0.61	1.07	1.48
55-59	2,924	5,201	10,267	1,100	1,957	3,863	1.44	3.03	4.35	0.62	1.14	1.60
60-64	2,720	4,771	9,501	1,195	2,096	4,175	1.15	2.64	3.86	0.59	1.16	1.66
65-69	2,401	4,156	8,371	1,234	2,135	4,301	0.82	2.18	3.29	0.50	1.12	1.64
70-74	1,872	3,208	6,561	1,086	1,862	3,807	0.39	1.62	2.60	0.31	0.94	1.48
75-79	1,365	2,325	4,802	893	1,521	3,141	-0.01	1.07	1.92	0.07	0.70	1.22

Note: Smoking levels are defined as follows: light smoking, 1-19 cigarettes per day; moderate smoking, 20-39 cigarettes per day; and heavy smoking, 40+ cigarettes per day.

Source: Report from Dr. Gerry Oster to Mr. Colin Church, Estimates of the Economic and Noneconomic Health Consequences of Smoking, Smoking Cessation, and Reductions in the Amount Smoked, December 12, 1986. This report was based on earlier work reported in Oster, Colditz, and Kelly, "The Economic Costs of Smoking and Benefits of Quitting for Individual Smokers," Preventive Medicine, No. 13, 1984, pp. 377-389 and Oster, Huse, Delea, and Colditz, "Cost-Effectiveness of Nicotine Gum as an Adjunct to Physician's Advice Against Cigarette Smoking," Journal of the American Medical Association, No. 256, 1986, pp. 1315-1318.

consider the following example. Suppose we wish to choose the most cost-effective of two public health programs, A and B. Program A costs $10,000 today and saves one life today, and Program B costs $10,000 today and saves one life in 40 years.

Applying discounting techniques to the problem would tell us that $10,000 today is equivalent to spending $70,000 (constant dollars) in 40 years (using a 5% discount rate and assuming no price inflation or deflation). This would produce a time consistent cost-per-life-saved ratio of $70,000/1 = 70000. Alternatively, applying discounting techniques would tell us that saving a life in 40 years is time equivalent to saving 1/7 life today (also using a 5% discount rate), again producing a time consistent cost-per-life-saved ratio of 70000 (i.e., $10,000/ 1/7 = 70000). In comparison, maintaining a consistent time relationship between dollars and lives for Program A would result in a cost-per-life-saved ratio of $10,000/1 = 10000. Thus applying principles of time adjustment to the analysis would demonstrate that Program A costs less per life saved, and, hence, is preferred on economic grounds.

In contrast, assigning equal value to a life regardless of when it occurs means that if it is worth spending $70,000 (constant dollars) in year 40 to save a life, it is worth spending $70,000 (constant dollars) in year 1 to save a life. And if it is worth spending $10,000 (constant dollars) in year 1 to save a life, it is worth spending $10,000 (constant dollars) in year 40 to save a life. Yet why should we spend $70,000 in year 1 to save a life when we could save the life with an expenditure of only $10,000, leaving funds for additional life-saving or other activities? Failure to discount would lead to the false conclusion that the two health programs were of equal cost effectiveness.[36]

[36] *For further discussion of the reason for discounting future life years see Milton C. Weinstein and William B. Stason, "Foundations of Cost Effectiveness Analysis for Health and Medical Practices," The New England Journal of Medicine (March 1977) p. 720.*

Table 5.6 Health Data Used in the Health Impact Model: Costs of Smoking

Age/Sex Group	Reductions in Expected Lifetime Medical Care Costs for the Treatment of Smoking-Related Diseases (1986$)						Increases in Years of Life Expectancy					
	Discounted at 0 Percent			Discounted at 5 Percent			Discounted at 0 Percent			Discounted at 5 Percent		
	Smoking Level			Smoking Level			Smoking Level			Smoking Level		
	Light	Moderate	Heavy	Light	Moderate	Heavy	Light	Moderate	Heavy	Light	Moderate	Heavy
Men												
35-39	4,825	8,622	13,419	940	1,680	2,615	3.64	5.08	6.21	0.72	0.99	1.22
40-44	4,615	7,984	12,233	1,074	1,857	2,846	3.27	4.60	5.62	0.78	1.07	1.32
45-49	4,240	7,056	10,743	1,166	1,940	2,954	2.81	4.00	4.90	0.79	1.10	1.35
50-54	3,748	5,944	9,079	1,208	1,916	2,926	2.28	3.32	4.07	0.75	1.07	1.32
55-59	3,118	4,710	7,358	1,163	1,757	2,745	1.74	2.60	3.20	0.67	0.97	1.21
60-64	2,471	3,597	5,869	1,079	1,571	2,564	1.22	1.90	2.36	0.55	0.83	1.03
65-69	1,844	2,643	4,477	922	1,321	2,238	0.78	1.32	1.65	0.41	0.66	0.83
70-74	1,256	1,811	3,182	720	1,038	1,824	0.41	0.82	1.06	0.26	0.47	0.61
75-79	805	1,188	2,156	526	776	1,408	0.17	0.49	0.67	0.14	0.32	0.44
Women												
35-39	2,150	4,301	8,849	365	730	1,503	1.65	3.18	4.41	0.31	0.54	0.73
40-44	2,071	4,047	8,290	423	826	1,692	1.50	2.94	4.10	0.35	0.60	0.82
45-49	2,095	4,037	8,196	508	979	1,987	1.29	2.64	3.71	0.36	0.64	0.88
50-54	1,917	3,598	7,383	546	1,026	2,105	1.05	2.28	3.25	0.35	0.65	0.91
55-59	1,686	3,064	6,529	574	1,043	2,224	0.75	1.85	2.69	0.31	0.63	0.89
60-64	1,418	2,550	5,748	567	1,020	2,299	0.46	1.40	2.10	0.24	0.56	0.81
65-69	1,111	2,013	4,707	515	934	2,184	0.19	0.97	1.52	0.15	0.45	0.69
70-74	828	1,514	3,625	449	821	1,966	-0.03	0.59	1.01	0.04	0.32	0.52
75-79	553	1,009	2,454	352	642	1,562	-0.14	0.33	0.63	-0.04	0.21	0.38

Note: Smoking levels are defined as follows: light smoking, 1-19 cigarettes per day; moderate smoking, 20-39 cigarettes per day; and heavy smoking, 40+ cigarettes per day.

Source: Report from Dr. Gerry Oster to Mr. Colin Church, Estimates of the Economic and Noneconomic Health Consequences of Smoking, Smoking Cessation, and Reductions in the Amount Smoked, December 12, 1986. This report was based on earlier work reported in Oster, Colditz, and Kelly, "The Economic Costs of Smoking and Benefits of Quitting for Individual Smokers," Preventive Medicine, No. 13, 1984, pp. 377-389 and Oster, Huse, Delea, and Colditz, "Cost-Effectiveness of Nicotine Gum as an Adjunct to Physician's Advice Against Cigarette Smoking," Journal of the American Medical Association, No. 256, 1986, pp. 1315-1318.

The Tobacco Farming Impacts are presented next. These include the effects of the cigarette modifications on significant economic variables of the tobacco farming sector. For each economic variable, the units of measurement are given along with the absolute change and the percentage change expected to result. The first variable is the price of U.S. produced tobacco. The 1986 price of tobacco was about $1.50 per pound. The next two variables are the quantities of U.S tobacco sold in the domestic and export markets. Total sales in both markets for 1986 were about 1500 million pounds. The fourth Tobacco Impact variable is revenue, which is the product of the price and the total quantity sold. This was about $2.25 billion in 1986. The fifth variable estimates changes in the revenue expected to be earned by the holders of the tobacco growing rights. The last tobacco sector variable is called producers' surplus and is a measure of the profits expected to be earned by tobacco growers. It is estimated as total tobacco revenue less costs of production less quota lease payments to holders of tobacco growing rights (even if the growers and rights holders are the same party). These estimates are derived using eqs. (1) through (4) of table 4.6.

The Cigarette Industry Impacts include similar variables of significance to the cigarette industry. First is the wholesale price of cigarettes. This price includes the federal excise tax of $8 per thousand and was $33.75 per thousand in December 1985. The next two variables are the quantities of U.S produced cigarettes sold in the domestic and export markets. The domestic sales in 1986 were about 583 billion cigarettes, while the export sales were about 65 billion cigarettes. The fourth cigarette impact variable is company revenue, which is the product of the price (net of the federal excise tax) and the total quantity sold. Revenue was about $16.7 billion in 1986.

The fourth impact category includes the federal tax revenue from the excise tax and an economic measure of consumer satisfaction called "Consumers' Surplus." The federal excise tax is levied on cigarettes sold to the

Table 5.7 Data Used in the Health Impact Model: Number of Smokers by Age, Sex, and Smoking Level

Age/Sex Group	Smoking Level		
	Light	Moderate	Heavy
Men			
25-29	1,666,782	1,834,197	269,638
30-34	1,249,581	1,765,457	639,926
35-39	925,225	1,623,575	594,598
40-44	606,222	1,308,461	505,850
45-49	516,630	1,108,678	421,240
50-54	396,307	866,801	381,493
55-59	418,716	954,575	349,154
60-64	455,495	694,539	351,124
65-69	304,998	412,931	185,628
70-74	288,958	300,528	60,201
75-791	66,055	85,783	40,982
Women			
25-29	1,698,120	1,613,576	185,879
30-34	1,352,630	1,418,967	280,645
35-39	1,055,831	1,238,938	359,603
40-44	852,849	1,131,875	324,219
45-49	695,662	1,014,416	275,589
50-54	676,394	870,198	162,463
55-59	708,978	897,446	159,714
60-64	625,800	662,476	83,405
65-69	450,579	464,475	53,438
70-74	381,295	268,673	18,807
75-79	178,298	126,428	19,962

NOTE: Smoking levels are defined as follows: light smoking, 1-19 cigarettes per day; moderate smoking, 20-39 cigarettes per day; and heavy smoking, 40+ cigarettes per day.

domestic wholesale market and is included in the wholesale price. State and local cigarette taxes are levied after the manufacturer sells to the distributor and are not included in the wholesale price. Because the supply and demand model is based on the wholesale market for cigarettes, only the federal taxes are included explicitly in the analysis. Although state tax rates vary widely, the total revenue currently collected by all the states combined is almost identical to federal collections because the weighted average state tax rate is 16.2 cents per package,[37] just slightly higher than the 16 cents per package implied by the federal tax rate of eight dollars per 1000. Local (municipal and county) cigarette tax revenue currently is about 5 percent of

[37]*The Tobacco Institute, The Tax Burden on Tobacco. Historical Compilation, vol 21 (1986), (Washington DC: The Tobacco Institute), p. 204.*

Table 5.8 Health Impact Model: Results

Cigarette Modification Case Scenario			Health Impacts Per Cigarette at Risk Per Day[a]	
Discount Rate (%)	Lag Specification	Direction of Cigarette Consumption Change	Medical Care Costs ($)	Life Expectancy (life-years)
0	no lag	decrease	-197	+0.114
0	no lag	increase	+199	-0.097
0	4-yr. lag	decrease	-189	+0.109
0	4-yr. lag	increase	+194	-0.094
5	no lag	decrease	-44	+0.025
5	no lag	increase	+48	-0.022
5	4-yr. lag	decrease	-37	+0.020
5	4-yr. lag	increase	+40	-0.019

[a]Health impacts listed are those generated by modification-induced cigarette consumption changes only. Health impacts due to possible changes in tar, nicotine, and C_0 content are not included. Results indicate impacts per cigarette "at risk" per day, meaning per cigarette impacts based on cigarettes smoked by 25-to 79-year-olds only.

the size of federal excise tax revenue.[38] Thus, a rough estimate of the impact on federal, state, and local cigarette taxes combined could be obtained by multiplying the federal excise tax impact reported in the table by a factor of 2.05.

The second impact in this fourth category is Consumers' Surplus, which is a measure of the difference between what consumers are willing to pay for a product and what they are required to pay. Cigarette modifications can affect consumers' willingness to pay through changes in taste or convenience, or what they are required to pay through changes in production costs. In these impact analyses, Consumers' Surplus takes into account estimated changes in production costs, together with alternative assumptions regarding changes in demand.

The fifth impact category covers the effects on medical costs and years of life expectancy associated with changes in cigarette consumption. These impacts are derived by tracing the modification-induced changes in cigarette production costs and shifts in the demand for cigarettes through the economic model to arrive at changes in cigarette consumption. Changes in cigarette consumption are then linked to health data that relate rates of daily cigarette consumption to the two categories of cigarette health damage included in the study: medical care costs and losses in life expectancy. Changes in medical care costs are stated in millions of dollars and changes in life expectancy are stated in years of life. Both health care damage variables are stated in present value terms discounted at zero and five percent over the life of the consumer.

The last impact category covers the employment impacts of the cigarette modifications. There are six economic sectors related to cigarette production that could be affected

[38]*The Tobacco Institute, The Tax Burden on Tobacco, table 1, p. 4.*

Table 5.9 Data Used to Compute Direct and Indirect Employment Effects.

SECTOR	Tobacco	Cigarettes	Warehouse	Support	Wholesale	Retail
BASELINE EMPLOYMENT (FT Equivalent Jobs)	35,000	50,000	1,400	7,000	34,500	31,000
DIRECT EFFECTS (FT Equivalent Jobs)						
Decrease Circumference	0	$6000 \times EU_{td}$	0	−240	0	0
Increase % Expanded Tobacco	0	0	0	0	0	0
Increase Paper Weight	0	+1000	+500	0	0	
Decrease Paper Porosity	0	0	0	0	0	0
Add Chemical	0	+165	0	+125	0	0
INDIRECT EFFECTS						
Employment Elasticities with respect to	1.5 EQt	1.5 EQc	1.2 EQt	1.0 EQc	1.0 EQc	0.5 EQcd

NOTATION: EU_{td} = proportional change in domestic tobacco content per cigarette
EQ_t = proportional change in quantity of tobacco
EQ_c = proportional change in quantity of cigarette sales
EQ_{cd} = proportional change in quantity of domestic cigarette sales

SOURCE: Source: David Greenberg, "The Employment Implications of Proposed Cigarette Design Modifications to Reduce Cigarette Ignition Propensity," *Report No. 6,* Technical Study Group.

by the product modifications. These are: tobacco farming; cigarette manufacturing; tobacco warehousing; support industries such as utilities, paper, and flavorings; wholesale distribution; and retail distribution including vending machines. For each of these economic sectors the estimated impact of the modification is stated in terms of the change in the number of full-time equivalent jobs. The total employment impact for all sectors combined is also presented. In interpreting these employment impacts, one should note that significant part-time employment in some of these sectors, especially tobacco farming, means that the number of persons affected by the modification is greater than reflected in the full-time equivalent estimate.

5.3 Results of the Analysis

The results of the impact analyses presented in full detail in appendix C are summarized in this subsection. Here the six impact analyses for each particular modification have been consolidated into a single table. These are presented below for each modification in tables 5.11 through 5.15. The first is discussed in greater detail to provide a framework for understanding the others. The fire loss impacts presented in these five tables all assume a 75 percent reduction in ignition propensity.

5.3.1 Decrease in Circumference

Table 5.2 showed that decreasing cigarette circumference is estimated to reduce the cost of producing cigarettes. The reduction in cost is driven by a decrease of nearly 30 percent in the quantity of domestic tobacco required. Paper costs are estimated to decrease by 16 percent, and other costs by 0.34 percent on net. The total change in production cost is estimated to be a decrease of about 3 percent.

Table 5.11 summarizes the results of two analyses for this modification. (See appendix tables C.1 through C-6 for more detail.) First the types of impacts are listed, grouped by major category. Then, in the first two data columns, results

Table 5.10 Illustration of Impact Analysis Report Presented in Appendix C

Modification: Decrease Circumference from 25 to 21 millimeters
Assumptions: Four-year Grace Period, and No Change in Domestic Cigarette Demand
Cost Impacts (%): Tobacco Content = -29.40 Paper Cost = -16.00 Other Cost = -1.40
Change in Tar and Nicotine (%): 0.0

First-Order Impacts:

Fire Impacts:: Lives Saved (or Life Years Gained), Injuries Avoided,, and Property Losses (Million $) Avoided

Year	25% Fewer Fires				50% Fewer Fires				75% Fewer Fires			
	Lives	Life Years	Number Injured	Prop Loss	Lives	Life Years	Number Injured	Prop Loss	Lives	Live Years	Number Injured	Prop Loss
1986	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	353	10833	1614	106	720	22114	3294	217	1088	33395	4975	328
1991	342	10509	1574	105	699	21454	3212	214	1056	32399	4851	323
1992	333	10210	1535	103	679	20843	3134	211	1025	31476	4733	319
1993	323	9901	1494	102	658	20212	3049	208	994	30522	4604	314
1994	315	9662	1460	101	643	19724	2980	205	970	29786	4500	310
1995	305	9369	1415	99	623	19127	2889	202	941	28884	4363	305
PV Sum (0%):	1971	60483	9091	616	4023	123473	18559	1257	6075	186462	28026	1899
PV Sum (5%):	1377	18714	6350	430	2811	38203	12964	877	4245	57693	19577	1324

Second-Order Impacts:

Tobacco Farming Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Tobacco	$/Lb	-0.08	-5.0
Domestic Tobacco Sales	Million Lbs	-195	-23.7
Export Tobacco Sales	Million Lbs	55	10.0
Total Tobacco Revenue	Million $	-302	-14.7
Quota Lease Revenue	Million $	-92	-29.8
Producers' Surplus	Million $	-34	N.A.

Cigarette Industry Impacts:	**UNITS**	**Absolute Change**	**% Change**
Price of Cigarettes	$/1000	-1.13	-3.3
Domestic Cigarettes Sales	Millions	5348	1.0
Export Cigarettes Sales	Millions	815	1.4
Total Cigarette Revenue (Net of Federal Excise Tax)	Million $	-456	-3.0

Tax & Consumer Impacts:	**Units**	**Absolute Change**	**% Change**
Federal Excise Tax Revenue	Million $	43	1.0
Consumers' Surplus	Million $	605	N.A.

Health Impacts:

Discount Rate	Change in Medical Costs (PV 1986 Million $)	Change in Expected Life (PV Years)
0 %	2208	-1068777
5 %	456	-211320

Employment Impacts by Sector (Change in Full-Time Equivalent Jobs):

2 Sector:	Tobacco	Cigarette	Warehouse	Support	Wholesale	Retail	TOTAL
Impact:	-4887	-898	-156	-153	328	142	-5623

Table 5.11 Impacts of Decreasing Cigarette Circumference from 25 to 21 Millimeters: Summary

Impacts	Four-Year Grace Period		Immediate Implementation	
	Change in Amount	Change in Percent	Change in Amount	Change in Percent
First-Order Impacts				
Fire[a]				
Lives saved OR	4,200	75.0	8,400	75.0
Life-years gained	57,700	75.0	115,000	75.0
Injuries avoided	19,600	75.0	38,500	75.0
Property loss avoided (mill.$)	1,300	75.0	2,500	75.0
Second-Order Impacts				
Tobacco Farming[b]				
Tobacco price ($/lb.)	-0.08	-5.0	-0.08	-5.0
Domestic sales (mill.lbs.)	-190	-23.7	-210	-23.7
Tobacco revenue (mill.$)	-300	-14.7	-330	-14.7
Cigarette Industry[b]				
Cigarette price ($/1000)	-1.13	-3.3	-1.13	-3.3
Domestic sales (mill.cig.)	5,300	1.0	5,900	1.0
Cigarette revenue (mill.$)	-460	-3.0	-500	-3.0
Tax and Consumer[b]				
Fed. Excise Tax Rev. (mill.$)	45	1.0	50	1.0
Consumer Surplus (mill.$)	600		660	
Health[a]				
Medical costs (mill.$)	450		570	1.0
Life-years (PV yrs.)	-211,000		-265,000	
Employment[b]				
Tobacco Sector (FT equiv.jobs)	-4,900		-5,300	-4.0
Cigarette Sector (FT equiv.jobs)	-900		-980	
Other (FT equiv.jobs)	160		180	

(a) All fire impacts (10-year period) and health impacts (lifetime) are given in present values at a 5% discount rate; fire loss savings assume a 75 percent reduction in the probability of ignition.
(b) Reported for one year only (the first year impact occurs).

are given assuming a four-year delay prior to implementation. In the second two columns, results are given assuming immediate implementation. First the estimated amount of impact is given, and then the percentage change.

Looking first at the section on fire loss impacts, we can see from the first column the estimated positive effects, discounted at an annual compound rate of 5 percent. If this design modification made cigarettes 75 percent less likely to cause fires, an estimated 4,200 lives would be saved over the study period from 1986 to 1995. This number of saved lives is estimated to be equivalent to a gain in total life expectancy of 57,700 years, taking into account the ages of fire victims and current life expectancy at different ages. Injuries avoided are projected to total 19,600 over the study period. Present value property loss avoided over the 10-year period is estimated at $1.3 billion.

Looking next at tobacco farming impacts, we can see from the first two columns that the decrease in cigarette circumference is expected to have a negative effect on this sector. The design modification is predicted to cause tobacco price to fall 5 percent, which is a decrease of $0.08 per pound of leaf tobacco, assuming an average pre-modification price of $1.50 per pound. Price is estimated to fall because of the reduced demand for tobacco resulting from lower tobacco content per cigarette. Even though the lower price of cigarettes is expected to increase cigarette

Table 5.12 Impacts of Increasing the Percentage of Expanded Tobacco from 25 to 50 Percent: Summary

Impacts	Four-Year Grace Period		Immediate Implementation	
	Change in Amount	Change in Percent	Change in Amount	Change in Percent
First-Order Impacts				
Fire[a]				
Lives saved OR	4,300	75.0	8,500	75.0
Life-years gained	57,800	75.0	115,000	75.0
Injuries avoided	19,600	75.0	38,600	75.0
Property loss avoided (mill.$)	1,300	75.0	2,500	75.0
Second-Order Impacts				
Tobacco Farming[b]				
Tobacco price ($/lb.)	-0.04	-2.7	-0.04	-2.7
Domestic sales (mill.lbs.)	-80	-9.6	-90	-9.6
Tobacco revenue (mill.$)	-130	-6.2	-140	-6.2
Cigarette Industry[b]				
Cigarette price ($/1000)	-0.49	-2.7	-0.04	-2.7
Domestic sales (mill.cig.)	2,300	0.4	2,500	0.4
Cigarette revenue (mill.$)	-190	-1.3	-210	-1.3
Tax and Consumer[b]				
Fed. Excise Tax Rev. (mill.$)	20	0.4	20	0.4
Consumer Surplus (mill.$)	260		290	
Health[a]				
Medical costs (mill.$)	200		250	0
Life-years (PV yrs.)	91,000		115,000	
Employment[b]				
Tobacco Sector (FT equiv.jobs)	-1,700		-1,900	-1.0
Cigarette Sector (FT equiv.jobs)	320		350	
Other (FT equiv.jobs)	180		200	

(a) All fire impacts (10-year period) and health impacts (lifetime) are given in present values at a 5% discount rate; fire loss savings assume a 75 percent reduction in the probability of ignition.
(b) Reported for one year only (the first year impact occurs).

sales (as may be seen from the next section on cigarette industry impacts), tobacco sales are estimated to fall by nearly 25 percent, an estimated decline of 190 million pounds of tobacco leaf in 1990, the first year the modification is assumed to occur. As a result of the lower price and lower sales, annual tobacco revenue is estimated to decline $300 million, a reduction of about 15 percent.

The next section of the table shows cigarette industry impacts to be mixed. The lower production costs are estimated to cause the cigarette price to fall about 3 percent, or $1.13 per 1000 cigarettes. The lower price is expected to stimulate a 1 percent increase in cigarette sales, which annually would amount to over 5 billion cigarettes. Despite the forecast of higher sales, industry revenue is estimated to decline by 3 percent or $460 million per year due to the lower price.

Impacts on federal excise tax revenue and consumer satisfaction, summarized in the next section, are both estimated to be positive. Because the federal excise tax rate is levied as a function of the quantity of cigarettes sold rather than price, federal excise tax revenue is estimated to rise as a result of the decrease in cigarette circumference. An estimated 1 percent increase means $45 million extra in annual excise tax revenue. The fall in cigarette price is estimated to generate an annual increase in consumers' surplus of $600 million, by increasing the difference between what

Table 5.13 Impacts of Adding Chemical to Tobacco Blend: Summary

Impacts	Four-Year Grace Period: Change in Amount	Four-Year Grace Period: Change in Percent	Immediate Implementation: Change in Amount	Immediate Implementation: Change in Percent
First-Order Impacts				
Fire[a]				
Lives saved OR	4,300	75.0	8,500	75.0
Life-years gained	58,000	75.0	115,000	75.0
Injuries avoided	19,700	75.0	38,700	75.0
Property loss avoided (mill.$)	1,300	75.0	2,500	75.0
Second-Order Impacts				
Tobacco Farming[b]				
Tobacco price ($/lb.)	0	-0.1	0	-0.1
Domestic sales (mill.lbs.)	-3	-0.4	-4	-0.4
Tobacco revenue (mill.$)	-5	-0.3	-6	-0.3
Cigarette Industry[b]				
Cigarette price ($/1000)	0.65	1.9	0.65	1.9
Domestic sales (mill.cig.)	-3,100	-0.6	-3,400	-0.6
Cigarette revenue (mill.$)	270	1.8	290	1.8
Tax and Consumer[b]				
Fed. Excise Tax Rev. (mill.$)	-25	-0.6	-30	-0.6
Consumer Surplus (mill.$)	-350		-380	
Health[a]				
Medical costs (mill.$)	-240		-300	0
Life-years (PV yrs.)	135,000		170,000	
Employment[b]				
Tobacco Sector (FT equiv.jobs)	-60		-70	0
Cigarette Sector (FT equiv.jobs)	-200		-230	
Other (FT equiv.jobs)	-170		-180	

(a) All fire impacts (10-year period) and health impacts (lifetime) are given in present values at a 5% discount rate; fire loss savings assume a 75 percent reduction in the probability of ignition.
(b) Reported for one year only (the first year impact occurs).

consumers are willing to pay for cigarettes and what they would be required to pay. This result assumes that the quality of the cigarette is unchanged.

The summary of health effects shows two undesirable impacts. Increased cigarette consumption is estimated to raise medical care costs by $450 million in present value terms, taking into account lifetime medical costs of all people expected to be affected over the 10-year period 1986 to 1995. Increased disease and illness are estimated to reduce total life expectancy over 200 thousand years, taking into account all smokers expected to be affected over the study period and adjusting for a 5 percent time preference. (It should be noted, however, that possible desirable health effects of decreased levels of tar, nicotine, and CO per puff are not taken into account in these results.)

Negative employment impacts are predicted in both the tobacco and cigarette sectors due to the large reductions in tobacco requirements. In the tobacco farm sector, the equivalent of about 5,000 full-time jobs are estimated to be lost, about 14 percent of tobacco farming jobs, but a negligible change in terms of total national employment. Since many farm workers are employed part time in tobacco growing, the number of workers affected is likely to be larger than 5,000. A small overall gain of 160 full-time equivalent jobs is forecast in the other sectors, including retail and wholesale trade and supporting industries, due to the projected increase in cigarette sales.

The above results are based on the assumption that

Table 5.14 Impacts of Increasing Cigarette Paper Weight from 24 to 32 Grams per Square Meter: Summary

Impacts	Four-Year Grace Period		Immediate Implementation	
	Change in Amount	Change in Percent	Change in Amount	Change in Percent
First-Order Impacts				
Fire[a]				
Lives saved OR	4,300	75.0	8,500	75.0
Life-years gained	58,000	75.0	115,000	75.0
Injuries avoided	19,700	75.0	38,700	75.0
Property loss avoided (mill.$)	1,300	75.0	2,500	75.0
Second-Order Impacts				
Tobacco Farming[b]				
Tobacco price ($/lb.)	0	0	0	0.1
Domestic sales (mill.lbs.)	−1	−0.1	−1	−0.1
Tobacco revenue (mill.$)	−1	−0.1	−1	−0.1
Cigarette Industry[b]				
Cigarette price ($/1000)	0.16	0.5	0.16	0.5
Domestic sales (mill.cig.)	−750	−1.0	−820	−0.1
Cigarette revenue (mill.$)	65	0.4	70	0.4
Tax and Consumer[b]				
Fed. Excise Tax Rev. (mill.$)	−6	−0.1	−7	−0.1
Consumer Surplus (mill.$)	−85		−90	
Health[a]				
Medical costs (mill.$)	−60		−75	0
Life-years (PV yrs.)	32,600		41,000	
Employment[b]				
Tobacco Sector (FT equiv.jobs)	−15		−15	0
Cigarette Sector (FT equiv.jobs)	5		5	
Other (FT equiv.jobs)	390		425	

(a) All fire impacts (10-year period) and health impacts (lifetime) are given in present values at a 5% discount rate; fire loss savings assume a 75 percent reduction in the probability of ignition.
(b) Reported for one year only (the first year impact occurs).

consumers like the modified cigarettes just as well as existing cigarettes, that is, that there is no change in demand. If consumer demand for the modified cigarettes were lower than for existing cigarettes, due, for example, to a less pleasing taste, fire loss savings would be slightly higher. Tobacco farming impacts would be somewhat more negative due to a further reduction in the derived demand for tobacco. Cigarette industry effects would also be negative. Reduced smoking due to the lower demand would lower present value medical costs and increase life expectancy. The generally negative employment impacts of the modification would worsen.

The last two columns of the table show the results assuming immediate implementation of the modification. As would be expected, fire loss savings are greater than with the delayed implementation because savings are tallied over more years of the 10-year study period. For similar reasons, health impacts are greater. The other impacts differ only to the extent the baseline data for 1986 are larger in value than those for 1990.

5.3.2 Increased Use of Expanded Tobacco

As was shown in table 5.2, increased use of expanded tobacco—like decreased cigarette circumference—is esti-

Table 5.15 Impacts of Decreasing Paper Porosity from 35 to 10 Coresta Units: Summary

Impacts	Four-Year Grace Period		Immediate Implementation	
	Change in Amount	Change in Percent	Change in Amount	Change in Percent
First-Order Impacts				
Fire[a]				
Lives saved OR	4,300	75.0	8,500	75.0
Life-years gained	57,900	75.0	115,000	75.0
Injuries avoided	19,600	75.0	38,700	75.0
Property loss avoided (mill.$)	1,300	75.0	2,500	75.0
Second-Order Impacts				
Tobacco Farming[b]				
Tobacco price ($/lb.)	0	0	0	0
Domestic sales (mill.lbs.)	0	0	0	0
Tobacco revenue (mill.$)	0	0	0	0
Cigarette Industry[b]				
Cigarette price ($/1000)	0	0	0	0
Domestic sales (mill.cig.)	0	0	0	0
Cigarette revenue (mill.$)	0	0	0	0
Tax and Consumer[b]				
Fed. Excise Tax Rev. (mill.$)	0	0	0	0
Consumer Surplus (mill.$)	0		0	0
Health[a]				
Medical costs (mill.$)	0		0	0
Life-years (PV yrs.)	0		0	
Employment[b]				
Tobacco Sector (FT equiv.jobs)	0		0	0
Cigarette Sector (FT equiv.jobs)	0		0	
Other (FT equiv.jobs)	0		0	

(a) All fire impacts (10-year period) and health impacts (lifetime) are given in present values at a 5% discount rate; fire loss savings assume a 75 percent reduction in the probability of ignition.
(b) Reported for one year only (the first year impact occurs).

mated to reduce the costs of producing cigarettes. An increase in the percent of expanded tobacco in the blend from 25 percent to 50 percent is estimated to reduce domestic tobacco content of cigarettes by 12.73 percent. Other costs, which include imported tobacco, are estimated to decline on net by 0.58 percent. Overall the decrease in production cost is estimated at about 1 percent.

Table 5.12 summarizes the results of two case analyses for this modification. (See appendix tables C.7 through C.12 for more detailed results.) Impacts are comparable to those for decreased cigarette circumference. Taking the case of unchanged demand, there are positive fire loss savings; negative tobacco farm impacts; mixed cigarette industry impacts; positive tax and consumer impacts; undesirable health impacts (ignoring possible effects of reduced tar, nicotine, and CO content); and employment impacts that are mixed among sectors, but negative overall. Fire loss impacts tend to be slightly larger than those for decreased cigarette circumference because the secondary consumption effect is smaller in this case. Other impacts tend to be somewhat smaller for this modification than for the previous one for the same reason.

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5.3.3 Chemical Additive to Tobacco Blend

Table 5.2 shows an increase in "other costs" of 2.83 percent due to adding chemical to the tobacco blend. No other cost changes are indicated. This amounts to an increase in total production costs of about 2 percent.

Table 5.13 summarizes results for this modification. (See appendix tables C.13 through C.18 for more detailed results.) The positive impacts on fire losses are estimated at essentially the same amounts as for the previous two modifications, because the same percentage change in ignition propensity is assumed. In contrast to the previous two modifications, this one is estimated to have positive health impacts. Health impacts are estimated to be positive as a result of the secondary effect of higher production costs to reduce cigarette consumption. (Possible adverse health effects associated directly with the chemical additive are not taken into account.) Due to the inelasticity of the demand for cigarettes, manufacturers' revenue is estimated to rise slightly due to the higher price of cigarettes, even though sales are estimated to be somewhat lower. Tobacco farmers are expected to be affected only slightly, ignoring possible adverse effects on cigarette demand.

5.3.4 Increased Paper Weight

Table 5.2 reports that the increase in paper weight from 24 to 32 grams per square meter is expected to increase paper costs by an estimated 48.2 percent and other costs by 0.3 percent. While this is a sizable increase in paper costs, it amounts to about a 1 percent increase in total cigarette costs.

Table 5.14 summarizes the estimates of economic impact. (See appendix tables C.19 through C.24 for more detailed results.) As in the preceding cases, fire loss impacts are based on a 75 percent reduction in ignition propensity, and therefore, the amounts are about the same as before. Like the chemical additive, this modification is estimated to have positive health impacts due to a price-induced reduction in cigarette consumption. (However, possible negative health consequences associated with heavier paper are not taken into account.) Also like the chemical additive, this modification is expected to entail negligible change in tobacco content, and hence negligible impact on the farm sector, ignoring possible adverse effects on cigarette demand. Impacts on the cigarette industry, federal excise tax revenue, consumer satisfaction, and employment impacts are also estimated to be quite small, because the cost change is relatively small.

5.3.5 Decreased Paper Porosity

A decrease in paper porosity from 35 to 10 Coresta is estimated to entail an insignificant change in the overall price of cigarette paper, since minor positive and negative changes in manufacturing and material costs would largely offset each other. The analysis therefore assumes no change in paper costs and no change in tobacco or other manufacturing costs for this modification.

Table 5.15 summarizes the estimates of economic impact. (See appendix tables C.25 through C.30 for more detailed results.) As in the preceding cases, the change in fire ignition propensity is shown for a 75 percent reduction, resulting in fire loss savings comparable to those shown in the other summary tables. There are no measurable impacts other than fire impacts due to the decrease in paper porosity, ignoring possible changes in cigarette demand.

5.4 Sensitivity of Results to Key Assumptions

The results presented in section 5.3 are based on a complex set of data and assumptions which may be considered "best guess" values, in the sense that care was taken to select from available values those that appeared to be most appropriate. However, it is important to note that there are considerable uncertainties associated with many of the values, and that different results would be obtained with the use of different values. The purpose of this section is to examine the sensitivity of results to alternative values of data and assumptions in order to test their impact on outcome. The sensitivity analysis focuses on the following five areas:

(1) Time required for implementation of the design modification;

(2) Length of the study period;

(3) Value of the discount rate;

(4) Shifts in demand for cigarettes; and

(5) Change in the tar, nicotine, and carbon monoxide content of cigarettes.

5.4.1 Time Required (Grace Period) for Implementing the Design Modification

A delay in implementing a public policy is often allowed to facilitate the necessary transition. The typical advantage of a delay is easier (lower cost) compliance, and the disadvantage, a delay in obtaining the desired effect.

The purpose of this discussion is to compare the estimated impacts associated with two alternative implementation requirements:

(1) A four-year delay, and

(2) No delay.

While the cost data collected in the supporting study of industry cost data showed no significant difference between costs with and without the delay, this was predicated on the hypothesis that each modification could be done within the specified time. It was pointed out in the supporting study that in the case of several of the design modifications,

notably increased use of expanded tobacco and increased paper weight, the assumption of immediate implementation appears technically infeasible, due to the lack of necessary industrial capacity. The results based on immediate implementation for those cases should therefore be regarded only as a reference point.

In the case of fire-loss savings, delayed implementation means smaller total fire-loss savings over time as potential savings during the period of delay are foregone. The higher the time preference (as indicated by the value of the discount rate), the larger the estimated loss in benefits due to the time delay. The estimated effect of a four-year delay on fire-loss impacts may be seen by comparing impacts shown in the first two columns (delayed implementation) of tables 5.11 through 5.15 with those shown in the second two columns (immediate implementation). With the 5 percent discount rate used in computing those results, a delay of 4 years cuts estimated present value fire-loss impacts for 1986-1995 almost in half. Without discounting (0 discount rate as shown in tables C.1 - C.30), a four-year delay reduces these impacts by about 45 percent.

A four-year delay in implementation is shown to have a much smaller effect on estimated health impacts than on fire-loss impacts. With the 5 percent discount rate used in computing the results shown in tables 5.11 through 5.15, a delay of four years reduces health impacts (positive or negative) by roughly 25 percent. The smaller effect reflects the way health impacts are measured. They are measured as the modification-induced change in lifetime medical costs and in life expectancy of all people who are estimated to be affected within the 10-year study period. The modification-induced change is assumed to be a one-time event, brought about by a one-time change in smoking, rather than a recurring effect. The main effect of the implementation delay is, therefore, to lag the time until the change occurs; it has little effect on the absolute size of the change.

Delaying implementation is estimated to reduce farming impacts, cigarette industry impacts, and tax and consumer impacts. Because these are estimated as annual impacts, delaying implementation for four years will mean foregoing these impacts for four years.

5.4.2 Length of the Study Period

At the beginning of this study, it was hypothesized that the smoking-related fire problem might be declining rapidly over time due to declines in smoking and increases in the use of fire-resistant materials and fire mitigation technologies. It was hypothesized that a study period as long as 10 years might capture most of the fire-loss savings, and a 10-year study period was adopted for assessing fire-loss impacts.

The results of the impact analysis appear to be more sensitive to the length of the study period than was expected. Estimated annual fire-loss savings are projected to decline at a rate of only several percentage points each year.

In the case of lives saved, for example, the rate of decline results in approximately a 25 percent decline between 1986 and 1995. This means that significant fire-loss savings could be expected past the 10-year study period, and suggests that the present value estimates of these effects taken over 10 years are understatements of the total long-run fire-loss impacts. In the case of health impacts, the results appear relatively insensitive to the length of the study period. This is because the health effects are induced by a one-time change, but measured as life-time amounts. People aged 35 and over at the time the modification occurs, who change their behavior as a consequence, are assumed to be affected. People under the age of 35 are assumed to be affected by the change only if they reach the age of 35 within the designated 10-year study period. (This assumption is made because the health data base used in the study assigns health costs only to smokers aged 35 and over.) A 10-year study period means that health effects will be attributed to people down to the age of 25 (since they reach the age of 35 within the study period and incur health effects in the year they become 35). Extending the study period would include additional people below the age of 25, and, therefore, increase health impacts. Because the price elasticity of demand for 12- to 24-year-olds is larger than that for 25- to 79-year-olds, the change in cigarette consumption for 12- to 24-year-olds during their younger years is likely to be higher. However, since health impacts associated with changed cigarette consumption occur at a later date, discounting would reduce their significance. Therefore, a 10-year study period is probably sufficiently long to capture most of the health impacts.

Farming, cigarette industry, and tax and consumer impacts are expected to recur, at least in the short run. In the long run, there may be some decline in farming and cigarette industry impacts as unemployed resources are deployed to other uses. It should be noted that these impacts are shown in the tables for one year only, not over a 10-year study period.

5.4.3 Value of the Discount Rate

Impact estimates tend to be sensitive to the value of the discount rate because it lowers the relative weight of future values. The higher the discount rate, the lower the present value equivalent of a future amount, and vice versa. Thus, the higher the discount rate, the lower the present value of future fire-loss and lifetime health impacts.

The sensitivity of the results to the discount rate can be seen in appendix C tables by comparing the analysis results based on a 5 percent discount rate with those based on a 0 percent discount rate (the latter being the equivalent of no discounting) for fire-loss impacts and health impacts. Table C.1 shows present value fire-loss impacts to be about 30 percent lower based on a 5 percent discount rate than on a 0 percent rate. Table C.1 shows present value health impacts to be nearly 80 percent lower based on a 5 percent discount rate than on a 0 percent rate. Health impacts are more sensitive to the discount rate than are fire-loss impacts because the discount rate is used in developing the data base of lifetime health effects associated with smoking, as well as in computing the present value of health effects distributed over the 10-year study period.

5.4.4 Change in the Demand for Modified Cigarettes

The case analyses in appendix C were performed under the following three conditions of demand for modified cigarettes:

(1) No change in demand;

(2) A 5 percent decrease in demand (e.g., due to an undesirable taste change); and

(3) A 5 percent increase in demand (e.g., due to an improvement in cigarette taste, or an increase in consumption to compensate for a decline in nicotine content per cigarette).

Note that these alternative assumptions about demand are all purely hypothetical in that no measurement of the predicted change in demand for the five modifications of cigarette design was performed. The comparative results, however, indicate the sensitivity of the various impact categories to shifts in demand.

Consider first the sensitivity of results to a 5 percent decline in demand for cigarettes. The analyses showed that a decrease in the demand for modified cigarettes tends to increase fire-loss savings, increase farm losses, reduce cigarette sales and industry revenue, reduce federal excise tax revenue, reduce consumers' surplus, reduce medical costs and increase life-expectancy, and decrease employment.

Percentage changes in the various impact categories for decreased circumference cigarettes, associated with a 5 percent decrease in demand, are as follows: fire-loss savings increase by a matching 5 percent; losses in tobacco farm sales and revenue are about 10 percent greater; the estimated small increase in cigarette sales is reversed, and industry revenue losses increase by more than 200 percent; the small gain in federal excise tax revenue is reversed and becomes a loss; the gain in consumers' surplus is also reversed; the increase in medical costs is reversed and a decline results; the decline in life years changes to a gain; tobacco-related employment declines further.

Now consider the effect of an increase in demand of 5 percent. The analyses show that an increase in the demand for cigarettes due to the modification tends to decrease fire loss savings, decrease farm losses, increase cigarette sales and industry revenue, increase federal excise tax revenue, increase consumers' surplus, increase medical costs and decrease life expectancy, and offset employment losses. In magnitude, the impacts are about the same as those described for a decrease in demand; but, of course, the direction of change is reversed.

It may be concluded that the impact categories which are particularly sensitive to the assumption about demand for cigarettes are cigarette industry impacts, tax and consumer impacts, health impacts, and employment impacts. Fire-loss impacts and farm impacts are much less sensitive.

5.4.5 Change in Tar, Nicotine, and Carbon Monoxide Content of Modified Cigarettes

A factor of critical importance is the potential health impacts which may result from changing the chemical content of cigarettes as a side effect of changing their design. A change in chemical potency would affect *all* modified cigarettes. Hence, the size of the impact could easily be many times larger than health changes resulting from changes in consumption levels of constant-potency cigarettes, the only health impact included in the preceding analyses. For example, a percentage change in cigarette potency of approximately 10 percent that translated into a similar percentage change in health-risk exposure, would completely overwhelm health impacts resulting from a 1 percent change in production costs (holding potency constant).

Insufficient data precluded estimating health impacts from changes in chemical potency for the five hypothetical modifications. Tests with sample data, however, demonstrated the potential importance of this impact. Furthermore, the model has the capability of estimating the effect if sufficient data were available.

5.5 Summary

Thirty different economic impact analyses, plus sensitivity testing, were performed to assess what could be learned about the likely effects of reducing the ignition propensity of cigarettes. The analyses were based on five hypothetical design modifications: tobacco blend, chemical additives, cigarette size, and paper weight and porosity. Impacts investigated included first-order impacts—savings from having fewer cigarette fires—as well as seven potential second-order impacts. Second-order impacts may result if something other than cigarette ignition propensity is changed. Other changes might occur in the mix or quantity of raw materials, labor, and/or production processes for manufacturing cigarettes; the cost of producing cigarettes; and cigarette attributes such as taste, appearance, handling characteristics, and chemical potency. Second-order impacts, whether or not intended, may have an important bearing on the outcome of an effort to improve fire safety, and, therefore, should be taken into account in policy development.

First, economic theory was applied to the problem to identify potential areas of major concern. Second, an economic impact model was developed to enable quantitative estimation of those first- and second-order impacts which were expected to be most significant. Third, assumptions were made and data were compiled or drawn from supporting data studies for use in the economic impact model. Fourth, the model was exercised with the data and assumptions to generate results. Fifth, the results were analyzed.

Despite uncertainties introduced into the analysis by the need to make a number of assumptions and to use data to which varying levels of confidence can be attached, the

analysis yielded findings with important implications for decision making.

The potential direct benefit from eliminating the cigarette fire loss problem was found to be substantial: a savings potential each year of more than 1500 lives now lost to cigarette fires, roughly 7000 fire-related injuries, and close to half a billion dollars of property damage. Although it was initially hypothesized that this savings potential would fall dramatically over the next 10 years, this hypothesis was not supported by findings. It was projected that 10 years from now the potential for saving lives and avoiding injury will be about 75 percent as large as now, and that the potential for averting property damage will be about 90 percent as large.

In the absence of specific ignition performance data for the hypothesized design modifications, the direct potential fire loss impacts are estimated by applying 25, 50 and 75 percent reduction rates. The resulting benchmarks of fire damage reductions can be used for comparing performance-based results when they become available.

The quantitative analysis of second-order impacts focused on those estimated to result from changes in the factors of production and costs of manufacturing cigarettes.

- If it is assumed that the supply price of cigarettes fully reflects changes in production costs – and if consumer demand and cigarette potency are held constant – second-order impacts are estimated to be relatively small in percentage terms for the five modifications.

- The estimated changes in production costs which drive the secondary impacts range between −3 and +2 percent.

- The largest percentage sector changes are estimated for tobacco farming and tobacco industry employment for those modifications which entail a reduction in tobacco content. For example, tobacco farm revenue is estimated to fall by 15 percent and jobs in tobacco-related industries by 4 percent in response to a decrease in cigarette circumference. Furthermore, these impacts are likely to be concentrated regionally.

- Cost-driven health impacts, though estimated at no more than a one percent increase in smoking-related medical costs, appear large in absolute dollars. This is because they are taken as a percentage change in lifetime incidence-based medical costs and this base is a very large number. (In contrast, some of the impacts are estimated for one year only, or for a 10-year period only.) Cost-driven health impacts are positive for modifications which are estimated to increase production costs and thereby decrease cigarette consumption, and vice-versa.

- Excise revenue impacts are estimated to be small – no more than a 1 percent change ($50 million per year) – and represent transfer payments between sectors of the economy.

- Cigarette industry impacts are also estimated to be small, ranging from a 3 percent decrease in revenue for a decreased circumference cigarette, to a 2 percent increase for a chemical additive.

- Smokers are assumed to benefit (gain in consumers' surplus) from a modification which lowers cigarette prices below what prices otherwise would have been, and vice-versa.

It is important to note, however, that changes in consumer demand and changes in chemical potency are two additional sources of potential secondary impact not accounted for by the cost-driven changes discussed above.

- Analyses were performed of the impact of hypothetical demand shifts, and the effect of a given shift can be described: A modification which results in an increase in demand for cigarettes can be expected to have positive impact on the farm sector, the cigarette industry, excise taxes, and employment; and negative health impacts. However, there is little basis for specifying shifts in demand for these modifications.

- Use of the impact model with hypothetical changes in cigarette potency demonstrated large potential effects on secondary health impacts.

Including potential secondary impacts of cigarette modification in the study is not to diminish or obfuscate the objective of fire safety. To make sound decisions regarding fire safety requires as full an understanding as possible of the consequences of alternative actions. This understanding may allow undesirable consequences of actions to be avoided, overcome, or neutralized. For example, it may be possible to choose cigarette design modifications with fewer secondary impacts, or to use tax policy, statute, and technological innovation to neutralize unwanted side effects.

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Appendix A

Derivation of the Solution Equations for the Supply and Demand Equilibrium Model

Ther system of the nine equations that comprise the supply and demand equilibrium model presented in Table 4.1 of section 4 can be solved using the method of substitution. The objective is to express at least one of the endogenous variables in explicit form independent of the other endogenous variables. the endogenous variable that represents the key to this system of equations turns out to be IP_{td}, the domestic price of tobacco. The explicit solution for this variable is derived in the following seven steps.

1. Start with Eq (8):

$$(8)\quad EQ_t = \beta_{td}EQ_{td} + (1 - \beta_{td})EQ_{te}.$$

2. Use Eqs (6) and (7) for EQ_{td} and EQ_{te}, respectively:

$$EQ_t = \beta_{td}(-\eta_{td}EP_{td} + EQ_c\bar{F}_{td} + \overline{EU}_{td}) - \eta_{te}(1 - \beta_{td})EP_{td}.$$

3. Use Eqs (1) and (2) substituted into (3) to replace EQ_c:

$$EQ_t = -\beta_{td}\eta_{td}EP_{td} + \beta_{td}\bar{F}_{td}[\beta_{cd}(-\eta_{cd}EP_{cd} + \overline{ED}_{cd}) + (1 - \beta_{cd})(-\eta_{ce}EP_{ce} + \overline{ED}_{ce}) + \overline{EU}_{td}] - \eta_{te}(1 - \beta_{td})EP_{td}.$$

4. Use Eqs (4) and (5) to replace EP_{cd} and EP_{ce}, respectively:

$$EQ_t = [-\beta_{td}\eta_{td} - \eta_{te}(1 - \beta_{td})]EP_{td} + \beta_{td}\bar{F}_{td}[\beta_{cd}(-\eta_{cd})(\alpha_{td}EP_{td}\bar{F}_{td} + \overline{EC}) + \beta_{cd}\overline{ED}_{cd}] + \beta_{td}\bar{F}_{td}(1 - \beta_{cd})(-\eta_{ce})\gamma[\alpha_{td}EP_{td}(\bar{F}_{td} - \theta\overline{EU}_{td}) + (1 - \theta)\overline{EC}] + \beta_{td}\bar{F}_{td}(1 - \beta_{cd})\overline{ED}_{ce} + \beta_{td}\overline{EU}_{td}\bar{F}_{td}.$$

5. Collect terms from Step 4 (especially coefficients of EP_{td}):

$$EQ_t = EP_{td}[-\beta_{td}\eta_{td} - \eta_{te}(1 - \beta_{td}) - \beta_{td}\beta_{cd}\eta_{cd}\alpha_{td}\bar{F}^2_{td} - \beta_{td}\bar{F}_{td}(1 - \beta_{cd})\eta_{ce}\gamma\alpha_{td}(\bar{F}_{td} - \theta\overline{EU}_{td})] - \beta_{td}\beta_{cd}\eta_{cd}\bar{F}_{td}\overline{EC} + \beta_{td}\beta_{cd}\overline{ED}_{cd}\bar{F}_{td} - \beta_{td}(1 - \beta_{cd})\eta_{ce}\gamma(1 - \theta)\bar{F}_{td}\overline{EC} + [\beta_{td}(1 - \beta_{cd})\overline{ED}_{ce} + \beta_{td}\overline{EU}_{td}]\bar{F}_{td}.$$

6. By defining λ as the expression for all the coefficients of EP_{td}, this expression for EQ_t can be more simply stated as Eq (10).

$$(10)\quad EQ_t = -\lambda EP_{td} + \beta_{td}\beta_{cd}(\overline{ED}_{cd} - \eta_{cd}\overline{EC})\bar{F}_{td} + \beta_{td}(1 - \beta_{cd})[\overline{ED}_{ce} - \eta_{ce}\gamma(1 - \theta)\overline{EC}]\bar{F}_{td} + \beta_{td}\overline{EU}_{td}\bar{F}_{td},$$

where $\lambda = \beta_{td}\alpha_{td}\bar{F}_{td}[\beta_{cd}\eta_{cd}\bar{F}_{td} + (1 - \beta_{cd})\eta_{ce}\gamma(\bar{F}_{td} - \theta\overline{EU}_{td})] + \beta_{td}\eta_{td} + (1 - \beta_{td})\eta_{te}$.

7. The first solution equation, that for the domestic price of tobacco, is obtained by equating Eqs. (9) and (10):

$$\varepsilon EP_{td} = -\lambda EP_{td} + \beta_{td}\beta_{cd}(ED_{cd} - \eta_{cd}\overline{EC})\bar{F}_{td} + \beta_{td}(1 - \beta_{cd})[\overline{ED}_{ce} - \eta_{ce}\gamma(1 - \theta)\overline{EC}]\bar{F}_{td} + \beta_{td}\overline{EU}_{td}\bar{F}_{td}.$$

$$(11)\quad EP_{td} = \bar{F}_{td}\beta_{td}[\beta_{cd}(\overline{ED}_{cd} - \eta_{cd}\overline{EC}) + (1 - \beta_{cd})(\overline{ED}_{ce} - \eta_{ce}\gamma(1 - \theta)\overline{EC}) + \overline{EU}_{td}]/[\varepsilon + \lambda].$$

Eq (11) expresses EP_{td}, the proportional change in the domestic price of tobacco as an explicit function of only the parameters and and the exogenous variables. It represents a solution because there are no endogenous variables in the function. Because of the structure of the remaining equations in the model, this solution equation for EP_{td} represents the solution for the entire system of equations. That is, EP_{td} can be substituted into Eq (4) to obtain the solution for the price of domestic cigarettes, EP_{cd}. Then, EP_{cd} and EP_{td} can be used to solve Eq (5) for the price of exported cigarettes. Eqs (1), (2) and (3) can then be solved for the quantities of cigarettes sold in both markets. The remaining four equations are solved in a similar fashion. Table 4.5 in section 4 presents the equations used to compute solution values for the endogenous variables.

Appendix B

Specification of the Health Impact Model

Case 1. No Lag, Cigarette Consumption Decrease

A. Dollar-Value Health Impacts

Participation Effect, Ages 35-79

$$H\$_i = WT_{35-79} \times QSP_{35-79} \times UA/(CPD \times NS_{35-79}) \times \sum_{a=1}^{9} \sum_{s=1}^{2} \sum_{l=1}^{3} NS_{a,s,l} \times Q\$_{a,s,l,i}$$

Participation Effect, Ages 25-34

$$+ WT_{25-34} \times QSP_{25-34} \times UA/(CPD \times NS_{25-34}) \times \sum_{y=25}^{34} SPW_{(35-y),i} \times \sum_{s=1}^{2} \sum_{l=1}^{3} NS_{a,s,l} \times S\$_{a=1,s,l,i}$$

Consumption Effect, Ages 35-79

$$+ WT_{35-79} \times QSC_{35-79}/NS_{35-79} \times \sum_{a=1}^{9} \sum_{s=1}^{2} \sum_{l=1}^{3} NS_{a,s,l} \times BQ\$_{a,s,l,i}$$

Consumption Effect, Ages 25-34

$$+ WT_{25-34} \times QSC_{25-34}/NS_{25-34} \times \sum_{y=25}^{34} SPW_{(35-y),i} \times \sum_{s=1}^{2} \sum_{l=1}^{3} NS_{a,s,l} \times BS\$_{a=1,s,l,i}$$

(Case 1, Continued)

B. Life-Year Health Impacts

Participation Effect, Ages 35-79

$$HY_i = WT_{35-79} \times QSP_{35-79} \times UA/(CPD \times NS_{35-79}) \times \sum_{a=1}^{9} \sum_{s=1}^{2} \sum_{l=1}^{3} NS_{a,s,l} \times QY_{a,s,l,i}$$

Participation Effect, Ages 25-34

$$+ WT_{25-34} \times QSP_{25-34} \times UA/(CPD \times NS_{25-34}) \times \sum_{y=25}^{34} SPW_{(35-y),i} \times \sum_{s=1}^{2} \sum_{l=1}^{3} NS_{a,s,l} \times SY_{a=1,s,l,i}$$

Consumption Effect, Ages 35-79

$$+ WT_{35-79} \times QSC_{35-79}/NS_{35-79} \times \sum_{a=1}^{9} \sum_{s=1}^{2} \sum_{l=1}^{3} NS_{a,s,l} \times BQY_{a,s,l,i}$$

Consumption Effect, Ages 25-34

$$+ WT_{25-34} \times QSC_{25-34}/NS_{25-34} \times \sum_{y=25}^{34} SPW_{(35-y),i} \times \sum_{s=1}^{2} \sum_{l=1}^{3} NS_{a,s,l} \times BSY_{a=1,s,l,i}$$

Case 2. No Lag, Cigarette Consumption Increase

A. Dollar-Value Health Impacts

Participation Effect, Ages 35-79

$$H\$_i = WT_{35-79} \times QSP_{35-79} \times UA/(CPD \times NS_{35-79}) \times \sum_{a=1}^{9} \sum_{s=1}^{2} \sum_{l=1}^{3} NS_{a,s,l} \times Q\$_{a,s,l,i}$$

Participation Effect, Ages 25-34

$$+ WT_{25-34} \times QSP_{25-34} \times UA/(CPD \times NS_{25-34}) \times \sum_{y=25}^{34} SPW_{(35-y),i} \times \sum_{s=1}^{2} \sum_{l=1}^{3} NS_{a,s,l} \times S\$_{a=1,s,l,i}$$

(Case 2, Continued)

Consumption Effect, Ages 35-79

$$+ WT_{35-79} \times QSC_{35-79}/NS_{35-79} \times \sum_{a=1}^{9} \sum_{s=1}^{2} \sum_{l=1}^{3} NS_{a,s,l} \times BS\$_{a,s,l',i}$$

Consumption Effect, Ages 25-34

$$+ WT_{25-34} \times QSC_{25-34}/NS_{25-34} \times \sum_{y=25}^{34} SPW_{(35-y),i} \times \sum_{s=1}^{2} \sum_{l=1}^{3} NS_{a,s,l} \times BS\$_{a=1,s,l',i}$$

B. Life-Year Health Impacts

Participation Effect, Ages 35-79

$$HY_i = WT_{35-79} \times QSP_{35-79} \times UA/(CPD \times NS_{35-79}) \times \sum_{a=1}^{9} \sum_{s=1}^{2} \sum_{l=1}^{3} NS_{a,s,l} \times QY_{a,s,l,i}$$

Participation Effect, Ages 25-34

$$+ WT_{25-34} \times QSP_{25-34} \times UA/(CPD \times NS_{25-34}) \times \sum_{y=25}^{34} SPW_{(35-y),i} \times \sum_{s=1}^{2} \sum_{l=1}^{3} NS_{a,s,l} \times SY_{a=1,s,l,i}$$

Consumption Effect, Ages 35-79

$$+ WT_{35-79} \times QSC_{35-79}/NS_{35-79} \times \sum_{a=1}^{9} \sum_{s=1}^{2} \sum_{l=1}^{3} NS_{a,s,l} \times BSY_{a,s,l',i}$$

Consumption Effect, Ages 25-34

$$+ WT_{25-34} \times QSC_{25-34}/NS_{25-34} \times \sum_{y=25}^{34} SPW_{(35-y),i} \times \sum_{s=1}^{2} \sum_{l=1}^{3} NS_{a,s,l} \times BSY_{a=1,s,l',i}$$

Case 3. Four-Year Lag, Cigarette Consumption Decrease

A. Dollar-Value Health Impacts

Participation Effect, Ages 35-79

$$H\$_i = WT_{35-79} \times SPW4_{,i} \times QSP_{35-79} \times UA/(CPD \times NS_{35-79}) \times \sum_{a=1}^{9} \sum_{s=1}^{2} \sum_{l=1}^{3} NS_{a,s,l} \times Q\$_{a,s,l,i}$$

Participation Effect, Ages 31-34

$$+WT_{31-34} \times SPW4_{,i} \times QSP_{25-34} \times UA/(CPD \times NS_{31-34}) \times \sum_{y=31}^{34} \sum_{s=1}^{2} \sum_{l=1}^{3} NS_{a,s,l} \times Q\$_{a=1,s,l,i}$$

Participation Effect, Ages 25-30

$$+WT_{25-30} \times QSP_{25-34} \times UA/(CPD \times NS_{25-30}) \sum_{y=25}^{30} SPW_{(35-y),i} \sum_{s=1}^{2} \sum_{l=1}^{3} NS_{a,s,l} \times S\$_{a=1,s,l,i}$$

Consumption Effect, Ages 35-79

$$+WT_{35-79} \times SPW4_{,i} \times QSC_{35-79}/NS_{35-79} \times \sum_{a=1}^{9} \sum_{s=1}^{2} \sum_{l=1}^{3} NS_{a,s,l} \times BQ\$_{a,s,l,i}$$

Consumption Effect, Ages 31-34

$$+WT_{31-34} \times SPW4_{,i} \times QSC_{25-34}/NS_{31-34} \times \sum_{y=31}^{34} \sum_{s=1}^{2} \sum_{l=1}^{3} NS_{a,s,l} \times BQ\$_{a=1,s,l,i}$$

Consumption Effect, Ages 25-30

$$+WT_{25-30} \times QSC_{25-34}/NS_{25-30} \times \sum_{y=25}^{30} SPW_{(35-y),i} \sum_{s=1}^{2} \sum_{l=1}^{3} NS_{a,s,l} \times BS\$_{a=1,s,l,i}$$

(Case 3, Continued)

B. Life-Year Health Impacts

Participation Effect, Ages 35-79

$$HY_i = WT_{35-79} \times SPW_{4,i} \times QSP_{35-79} \times UA/(CPD \times NS_{35-79}) \times \sum_{a=1}^{9} \sum_{s=1}^{2} \sum_{l=1}^{3} NS_{a,s,l} \times QY_{a,s,l,i}$$

Participation Effect, Ages 31-34

$$+WT_{31-34} \times SPW_{4,i} \times QSP_{25-34} \times UA/(CPD \times NS_{31-34}) \times \sum_{y=31}^{34} \sum_{s=1}^{2} \sum_{l=1}^{3} NS_{a,s,l} \times QY_{a=1,s,l,i}$$

Participation Effect, Ages 25-30

$$+WT_{25-30} \times QSP_{25-34} \times UA/(CPD \times NS_{25-30}) \sum_{y=25}^{30} SPW_{(35-y),i} \sum_{s=1}^{2} \sum_{l=1}^{3} NS_{a,s,l} \times SY_{a=1,s,l,i}$$

Consumption Effect, Ages 35-79

$$+WT_{35-79} \times SPW_{4,i} \times QSC_{35-79}/NS_{35-79} \times \sum_{a=1}^{9} \sum_{s=1}^{2} \sum_{l=1}^{3} NS_{a,s,l} \times BQY_{a,s,l,i}$$

Consumption Effect, Ages 31-34

$$+WT_{31-34} \times SPW_{4,i} \times QSC_{25-34}/NS_{31-34} \times \sum_{y=31}^{34} \sum_{s=1}^{2} \sum_{l=1}^{3} NS_{a,s,l} \times BQY_{a=1,s,l,i}$$

Consumption Effect, Ages 25-30

$$+WT_{25-30} \times QSC_{25-34}/NS_{25-30} \times \sum_{y=25}^{30} SPW_{(35-y),i} \sum_{s=1}^{2} \sum_{l=1}^{3} NS_{a,s,l} \times BSY_{a=1,s,l,i}$$

Case 4. Four Year Lag, Cigarette Consumption Increase

A. Dollar-Value Health Impacts

Participation Effect, Ages 35-79

$$H\$_i = WT_{35-79} \times SPW4_{,i} \times QSP_{35-79} \times UA/(CPD \times NS_{35-79}) \times \sum_{a=1}^{9} \sum_{s=1}^{2} \sum_{l=1}^{3} NS_{a,s,1} \times Q\$_{a,s,l,i}$$

Participation Effect, Ages 31-34

$$+WT_{31-34} \times SPW4_{,i} \times QSP_{25-34} \times UA/(CPD \times NS_{31-34}) \times \sum_{y=31}^{34} \sum_{s=1}^{2} \sum_{l=1}^{3} NS_{a,s,1} \times Q\$_{a=1,s,l,i}$$

Participation Effect, Ages 25-30

$$+WT_{25-30} \times QSP_{25-34} \times UA/(CPD \times NS_{25-30}) \sum_{y=25}^{30} SPW(35-y),i \sum_{s=1}^{2} \sum_{l=1}^{3} NS_{a,s,1} \times S\$_{a=1,s,l,i}$$

Consumption Effect, Ages 35-79

$$+WT_{35-79} \times SPW4_{,i} \times QSC_{35-79}/NS_{35-79} \times \sum_{a=1}^{9} \sum_{s=1}^{2} \sum_{l=1}^{3} NS_{a,s,1} \times BS\$_{a,s,1',i}$$

Consumption Effect, Ages 31-34

$$+WT_{31-34} \times SPW4_{,i} \times QSC_{25-34}/NS_{31-34} \times \sum_{y=31}^{34} \sum_{s=1}^{2} \sum_{l=1}^{3} NS_{a,s,1} \times BS\$_{a=1,s,1',i}$$

Consumption Effect, Ages 25-30

$$+WT_{25-30} \times QSC_{25-34}/NS_{25-30} \times \sum_{y=25}^{30} SPW(35-y),i \sum_{s=1}^{2} \sum_{l=1}^{3} NS_{a,s,1} \times BS\$_{a=1,s,1',i}$$

(Case 4, Continued)

B. Life-Year Health Impacts

Participation Effect, Ages 35-79

$$HY_i = WT_{35-79} \times SPW_{4,i} \times QSP_{35-79} \times UA/(CPD \times NS_{35-79}) \times \sum_{a=1}^{9} \sum_{s=1}^{2} \sum_{l=1}^{3} NS_{a,s,l} \times QY_{a,s,l,i}$$

Participation Effect, Ages 31-34

$$+WT_{31-34} \times SPW_{4,i} \times QSP_{25-34} \times UA/(CPD \times NS_{31-34}) \times \sum_{y=31}^{34} \sum_{s=1}^{2} \sum_{l=1}^{3} NS_{a,s,l} \times QY_{a=1,s,l,i}$$

Participation Effect, Ages 25-30

$$+WT_{25-30} \times QSP_{25-34} \times UA/(CPD \times NS_{25-30}) \sum_{y=25}^{30} SPW_{(35-y),i} \sum_{s=1}^{2} \sum_{l=1}^{3} NS_{a,s,l} \times SY_{a=1,s,l,i}$$

Consumption Effect, Ages 35-79

$$+WT_{35-79} \times SPW_{4,i} \times QSC_{35-79}/NS_{35-79} \times \sum_{a=1}^{9} \sum_{s=1}^{2} \sum_{l=1}^{3} NS_{a,s,l} \times BSY_{a,s,l',i}$$

Consumption Effect, Ages 31-34

$$+WT_{31-34} \times SPW_{4,i} \times QSC_{25-34}/NS_{31-34} \times \sum_{y=31}^{34} \sum_{s=1}^{2} \sum_{l=1}^{3} NS_{a,s,l} \times BSY_{a=1,s,l',i}$$

Consumption Effect, Ages 25-30

$$+WT_{25-30} \times QSC_{25-34}/NS_{25-30} \times \sum_{y=25}^{30} SPW_{(35-y),i} \sum_{s=1}^{2} \sum_{l=1}^{3} NS_{a,s,l} \times BSY_{a=1,s,l',i}$$

Table B. 1 Notation for Health Impact Model

Symbol	Definition
HS_i	Dollar-value health impacts per cigarette "at risk" per day, for discount rate i.
HY_i	Life-year health impacts per cigarette "at risk" per day, for discount rate i.
WT	Weight, by age class, reflecting proportion out of total cigarettes smoked by 25-79 year-olds that are smoked by that age class.
QSP	Quantity share for the participation effect, by age class.
QSC	Quantity share for the consumption effect, by age class.
UA	Underreporting adjustment for participation effect, to adjust for fact that smokers smoke more cigarettes per day than they claim.
CPD	Cigarettes per day, an average of average cigarettes smoked per day by current smokers and recent quitters.
NS_{25-34}, NS_{35-79} NS_{25-30}, NS_{31-34}	Number of current smokers, by age class.
a	Age group number for ages 35-79, where a=1 for 35-39, a=2 for 40-44,..., a=9 for 75-79.
y	Age, in years.
s	Sex, where s=1 for male and s=2 for female.
l	Smoking level number, where l=1 for 1-19 cigarettes per day, l=2 for 20-39 cigarettes per day, and l=3 for 40+ cigarettes per day.
$NS_{a,s,l}$	Number of smokers in age group a, sex s, and smoking level l.

Table B.1 Notation for Health Impact Model

Symbol	Definition
$Q\$_{a,s,l,i}$	Present value lifetime dollar health benefits of quitting per person in age group a, sex s, smoking level l, and at discount rate i.
$S\$_{a,s,l,i}$	Present value lifetime dollar health costs of smoking per person in age group a, sex s, smoking level l, and at discount rate i.
$QY_{a,s,l,i}$	Present value life-year health benefits of quitting per person in age group a, sex s, smoking level l, and at discount rate i.
$SY_{a,s,l,i}$	Present value life-year health costs of smoking per person in age group a, sex s, smoking level l, and at discount rate i.
$SPW_{(35-y),i}$ $SPW_{4,i}$	Single present worth factor, for discounting to the present values occurring (35-y) or 4 years hence at discount rate i.
$BQ\$_{a,s,l,i}$	Slope of the dollar-benefit dose-response curve for quitting for age group a, sex s, smoking level l, and discount rate i.
$BS\$_{a,s,l,i}$	Slope of the dollar-cost dose-response curve for smoking for age group a, sex s, smoking level l, and discount rate i.
$BQY_{a,s,l,i}$	Slope of the life-year benefit dose-response curve for quitting for age group a, sex s, smoking level l, and discount rate i.
$BSY_{a,s,l,i}$	Slope of the life-year cost dose-response curve for smoking for age group a, sex s, smoking level l, and discount rate i.
l'	Smoking level number, where l'=2 when l=1, l'=3 when l=2, and l'=3 when l=3.

Appendix C

Detailed Results of the Impact Analysis

Table C.1

Modification: Decrease Circumference from 25 to 21 millimeters
Assumptions: Four-year Grace Period, and No Change in Domestic Cigarette Demand
Cost Impacts (%): Tobacco Content = -29.40 Paper Cost = -16.00 Other Cost = -1.40
Change in Tar and Nicotine (%): 0.0

First-Order Impacts:

Fire Impacts:: Lives Saved (or Life Years Gained), Injuries Avoided,, and Property Losses (Million $) Avoided

Year	25% Fewer Fires				50% Fewer Fires				75% Fewer Fires			
	Lives	Life Years	Number Injured	Prop Loss	Lives	Life Years	Number Injured	Prop Loss	Lives	Live Years	Number Injured	Prop Loss
1986	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	353	10833	1614	106	720	22114	3294	217	1088	33395	4975	328
1991	342	10509	1574	105	699	21454	3212	214	1056	32399	4851	323
1992	333	10210	1535	103	679	20843	3134	211	1025	31476	4733	319
1993	323	9901	1494	102	658	20212	3049	208	994	30522	4604	314
1994	315	9662	1460	101	643	19724	2980	205	970	29786	4500	310
1995	305	9369	1415	99	623	19127	2889	202	941	28884	4363	305
PV Sum (0%):	1971	60483	9091	616	4023	123473	18559	1257	6075	186462	28026	1899
PV Sum (5%):	1377	18714	6350	430	2811	38203	12964	877	4245	57693	19577	1324

Second-Order Impacts:

Tobacco Farming Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Tobacco	$/Lb	-0.08	-5.0
Domestic Tobacco Sales	Million Lbs	-195	-23.7
Export Tobacco Sales	Million Lbs	55	10.0
Total Tobacco Revenue	Million $	-302	-14.7
Quota Lease Revenue	Million $	-92	-29.8
Producers' Surplus	Million $	-34	N.A.

Cigarette Industry Impacts:	**UNITS**	**Absolute Change**	**% Change**
Price of Cigarettes	$/1000	-1.13	-3.3
Domestic Cigarettes Sales	Millions	5348	1.0
Export Cigarettes Sales	Millions	815	1.4
Total Cigarette Revenue (Net of Federal Excise Tax)	Million $	-456	-3.0

Tax & Consumer Impacts:	**Unit**	**Absolute Change**	**% Change**
Federal Excise Tax Revenue	Million $	43	1.0
Consumers' Surplus	Million $	605	N.A.

Health Impacts:

Discount Rate	Change in Medical Costs (PV 1986 Million $)	Change in Expected Life (PV Years)
0 %	2208	-1068777
5 %	456	-211320

Employment Impacts by Sector (Change in Full-Time Equivalent Jobs):

2 Sector:	Tobacco	Cigarette	Warehouse	Support	Wholesale	Retail	TOTAL
Impact:	-4887	-898	-156	-153	328	142	-5623

Table C.2

Modification: Decrease Circumference from 25 to 21 millimeters
Assumptions: Four-year Grace Period, and 5.0% Decrease in Domestic Cigarette Demand
Cost Impacts (%): Tobacco Content = -29.40 Paper Cost = -16.00 Other Cost = -1.40
Change in Tar and Nicotine (%): 0.0

First-Order Impacts:

Fire Impacts: Lives Saved (or Life Years Gained), Injuries Avoided,, and Property Losses (Million $) Avoided

Year	25% Fewer Fires				50% Fewer Fires				75% Fewer Fires			
	Lives	Life Years	Number Injured	Prop Loss	Lives	Life Years	Number Injured	Prop Loss	Lives	Live Years	Number Injured	Prop Loss
1986	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	407	12504	1863	123	757	23228	3460	228	1106	33953	5058	333
1991	395	12131	1816	121	734	22535	3374	225	1073	32939	4932	329
1992	384	11785	1772	119	713	21893	3292	222	1043	32001	4812	324
1993	372	11428	1724	118	692	21230	3203	218	1011	31032	4681	319
1994	363	11153	1685	116	675	20718	3130	216	987	30283	4575	315
1995	352	10815	1634	114	655	20090	3035	212	957	29366	4436	310
PV Sum (0%):	2275	69816	10494	711	4225	129695	19494	1321	6176	189573	28494	1930
PV Sum (5%):	1590	21602	7330	496	2953	40128	13617	921	4316	58655	19904	1346

Second-Order Impacts:

Tobacco Farming Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Tobacco	$/Lb	-0.09	-5.8
Domestic Tobacco Sales	Million Lbs	-214	-26.0
Export Tobacco Sales	Million Lbs	64	11.6
Total Tobacco Revenue	Million $	-332	-16.1
Quota Lease Revenue	Million $	-106	-34.3
Producers' Surplus	Million $	-36	N.A.

Cigarette Industry Impacts:	**UNITS**	**Absolute Change**	**% Change**
Price of Cigarettes	$/1000	-1.14	-3.4
Domestic Cigarettes Sales	Millions	-21209	-4.0
Export Cigarettes Sales	Millions	943	1.6
Total Cigarette Revenue (Net of Federal Excise Tax)	Million $	-1114	-7.3

Tax & Consumer Impacts:	**Unit**	**Absolute Change**	**% Change**
Federal Excise Tax Revenue	Million $	-170	-4.0
Consumers' Surplus	Million $	-901	N.A.

Health Impacts:

Discount Rate	Change in Medical Costs (PV 1986 Million $)	Change in Expected Life (PV Years)
0 %	-8551	-4928016
5 %	-1648	-924229

Employment Impacts by Sector (Change in Full-Time Equivalent Jobs):

2 Sector:	Tobacco	Cigarette	Warehouse	Support	Wholesale	Retail	TOTAL
Impact:	-5265	-3958	-168	-438	-1080	-564	-11747

Table C.3

Modification: Decrease Circumference from 25 to 21 millimeters
Assumptions: Four-year Grace Period, and 5.0% Increase in Domestic Cigarette Demand
Cost Impacts (%): Tobacco Content = -29.40 Paper Cost = -16.00 Other Cost = -1.40
Change in Tar and Nicotine (%): 0.0

First-Order Impacts:

Fire Impacts: Lives Saved (or Life Years Gained), Injuries Avoided,, and Property Losses (Million $) Avoided

Year	25% Fewer Fires				50% Fewer Fires				75% Fewer Fires			
	Lives	Life Years	Number Injured	Prop Loss	Lives	Life Years	Number Injured	Prop Loss	Lives	Live Years	Number Injured	Prop Loss
1986	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	298	9161	1365	90	684	21000	3128	206	1070	32838	4892	322
1991	290	8888	1331	89	664	20373	3051	203	1038	31858	4770	318
1992	281	8635	1298	88	645	19793	2976	201	1008	30951	4654	314
1993	273	8373	1263	86	625	19193	2895	197	978	30013	4528	309
1994	266	8171	1234	85	610	18730	2830	195	954	29289	4425	305
1995	258	7924	1197	84	592	18163	2743	191	925	28402	4290	299
PV Sum (0%):	1666	51151	7688	521	3820	117251	17623	1194	5974	183351	27559	1867
PV Sum (5%):	1165	15826	5370	363	2669	36278	12310	833	4174	56730	19251	1302

Second-Order Impacts:

Tobacco Farming Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Tobacco	$/Lb	-0.06	-4.2
Domestic Tobacco Sales	Million Lbs	-175	-21.3
Export Tobacco Sales	Million Lbs	46	8.4
Total Tobacco Revenue	Million $	-272	-13.2
Quota Lease Revenue	Million $	-78	-25.2
Producers' Surplus	Million $	-31	N.A.

Cigarette Industry Impacts:	**UNITS**	**Absolute Change**	**% Change**
Price of Cigarettes	$/1000	-1.12	-3.3
Domestic Cigarettes Sales	Millions	31905	6.0
Export Cigarettes Sales	Millions	687	1.2
Total Cigarette Revenue (Net of Federal Excise Tax)	Million $	203	1.3

Tax & Consumer Impacts:	**Unit**	**Absolute Change**	**% Change**
Federal Excise Tax Revenue	Million $	255	6.0
Consumers' Surplus	Million $	2110	N.A.

Health Impacts:

Discount Rate	Change in Medical Costs (PV 1986 Million $)	Change in Expected Life (PV Years)
0 %	13172	-6376008
5 %	2722	-1260674

Employment Impacts by Sector (Change in Full-Time Equivalent Jobs):

Sector:	Tobacco	Cigarette	Warehouse	Support	Wholesale	Retail	TOTAL
Impact:	-4509	2163	-144	-133	-1736	848	228

Table C.4

Modification: Decrease Circumference from 25 to 21 millimeters
Assumptions: Immediate Implementation, and No Change in Domestic Cigarette Demand
Cost Impacts (%): Tobacco Content = −29.40 Paper Cost = −16.00 Other Cost = −1.40
Change in Tar and Nicotine (%): 0.0

First-Order Impacts:

Fire Impacts: Lives Saved (or Life Years Gained), Injuries Avoided,, and Property Losses (Million $) Avoided

Year	25% Fewer Fires				50% Fewer Fires				75% Fewer Fires			
	Lives	Life Years	Number Injured	Prop Loss	Lives	Life Years	Number Injured	Prop Loss	Lives	Live Years	Number Injured	Prop Loss
1986	402	12341	1814	112	821	25192	3703	228	1239	38044	5593	344
1987	388	11917	1752	110	793	24327	3576	225	1197	36738	5401	339
1988	376	11545	1700	109	768	23569	3470	222	1160	35592	5240	336
1989	365	11210	1660	108	746	22884	3390	220	1126	34558	5119	333
1990	353	10833	1614	106	720	22114	3294	217	1088	33395	4975	328
1991	342	10509	1574	105	699	21454	3212	214	1056	32399	4851	323
1992	333	10210	1535	103	679	20843	3134	211	1025	31476	4733	319
1993	323	9901	1494	102	658	20212	3049	208	994	30522	4604	314
1994	315	9662	1460	101	643	19724	2980	205	970	29786	4500	310
1995	305	9369	1415	99	623	19127	2889	202	941	28884	4363	305
PV Sum (0%):	3502	107496	16017	1054	7149	219445	32698	2152	10797	331394	49379	3250
PV Sum (5%):	37202	12501	818	5588	75946	25521	1670	8439	114690	38540	2523	

Second-Order Impacts:

Tobacco Farming Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Tobacco	$/Lb	−0.08	−5.0
Domestic Tobacco Sales	Million Lbs	−213	−23.7
Export Tobacco Sales	Million Lbs	60	10.0
Total Tobacco Revenue	Million $	−330	−14.7
Quota Lease Revenue	Million $	−101	−29.8
Producers' Surplus	Million $	−37	N.A.

Cigarette Industry Impacts:	**UNITS**	**Absolute Change**	**% Change**
Price of Cigarettes	$/1000	−1.13	−3.3
Domestic Cigarettes Sales	Millions	5855	1.0
Export Cigarettes Sales	Millions	892	1.4
Total Cigarette Revenue (Net of Federal Excise Tax)	Million $	−499	−3.0

Tax & Consumer Impacts:	**Unit**	**Absolute Change**	**% Change**
Federal Excise Tax Revenue	Million $	47	1.0
Consumers' Surplus	Million $	662	N.A.

Health Impacts:

Discount Rate	Change in Medical Costs (PV 1986 Million $)	Change in Expected Life (PV Years)
0 %	2374	−1154122
5 %	572	−264902

Employment Impacts by Sector (Change in Full-Time Equivalent Jobs):

Sector:	Tobacco	Cigarette	Warehouse	Support	Wholesale	Retail	TOTAL
Impact:	−5350	−983	−171	−167	359	156	−6156

Table C.5

Modification: Decrease Circumference from 25 to 21 millimeters
Assumptions: Immediate Implementation, and a 5.0% Decrease in Domestic Cigarette Demand
Cost Impacts (%): Tobacco Content = -29.40 Paper Cost = -16.00 Other Cost = -1.40
Change in Tar and Nicotine (%): 0.0

First-Order Impacts:

Fire Impacts: Lives Saved (or Life Years Gained), Injuries Avoided,, and Property Losses (Million $) Avoided

Year	25% Fewer Fires				50% Fewer Fires				75% Fewer Fires			
	Lives	Life Years	Number Injured	Prop Loss	Lives	Life Years	Number Injured	Prop Loss	Lives	Live Years	Number Injured	Prop Loss
1986	464	14245	2094	129	862	26462	3890	239	1260	38679	5686	349
1987	448	13756	2022	127	833	25553	3757	236	1217	37351	5491	345
1988	434	13327	1962	126	807	24756	3645	234	1179	36186	5328	341
1989	422	12939	1917	124	783	24037	3560	231	1145	35134	5204	338
1990	407	12504	1863	123	757	23228	3460	228	1106	33953	5058	333
1991	395	12131	1816	121	734	22535	3374	225	1073	32939	4932	329
1992	384	11785	1772	119	713	21893	3292	222	1043	32001	4812	324
1993	372	11428	1724	118	692	21230	3203	218	1011	31032	4681	319
1994	363	11153	1685	116	675	20718	3130	216	987	30283	4575	315
1995	352	10815	1634	114	655	20090	3035	212	957	29366	4436	310
PV Sum (0%):	4043	124082	18489	1217	7510	230503	34346	2260	10977	336923	50203	3304
PV Sum (5%):	3160	42943	14430	945	5870	79773	26807	1755	8580	116603	39183	2565

Second-Order Impacts:

Tobacco Farming Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Tobacco	$/Lb	-0.09	-5.8
Domestic Tobacco Sales	Million Lbs	-234	-26.0
Export Tobacco Sales	Million Lbs	70	11.6
Total Tobacco Revenue	Million $	-363	-16.1
Quota Lease Revenue	Million $	-116	-34.3
Producers' Surplus	Million $	-40	N.A.

Cigarette Industry Impacts:	**UNITS**	**Absolute Change**	**% Change**
Price of Cigarettes	$/1000	-1.14	-3.4
Domestic Cigarettes Sales	Millions	-23219	-4.0
Export Cigarettes Sales	Millions	1033	1.6
Total Cigarette Revenue (Net of Federal Excise Tax)	Million $	-1220	-7.3

Tax & Consumer Impacts:	**Unit**	**Absolute Change**	**% Change**
Federal Excise Tax Revenue	Million $	-186	-4.0
Consumers' Surplus	Million $	-986	N.A.

Health Impacts:

Discount Rate	Change in Medical Costs (PV 1986 Million $)	Change in Expected Life (PV Years)
0 %	-9344	5383399
5 %	-2085	1165669

Employment Impacts by Sector (Change in Full-Time Equivalent Jobs):

Sector:	Tobacco	Cigarette	Warehouse	Support	Wholesale	Retail	TOTAL
Impact:	-5764	-4333	-184	-480	-1182	-617	-12562

Table C.6

Modification: Decrease Circumference from 25 to 21 millimeters
Assumptions: Immediate Implementation, and a 5.0% Increase in Domestic Cigarette Demand
Cost Impacts (%): Tobacco Content = -29.40 Paper Cost = -16.00 Other Cost = -1.40
Change in Tar and Nicotine (%): 0.0

First-Order Impacts:

Fire Impacts: Lives Saved (or Life Years Gained), Injuries Avoided,, and Property Losses (Million $) Avoided

Year	25% Fewer Fires				50% Fewer Fires				75% Fewer Fires			
	Lives	Life Years	Number Injured	Prop Loss	Lives	Life Years	Number Injured	Prop Loss	Lives	Live Years	Number Injured	Prop Loss
1986	340	10436	1534	94	779	23923	3517	216	1219	37410	5499	338
1987	328	10078	1482	93	753	23101	3396	213	1177	36125	5311	334
1988	318	9764	1438	92	729	22381	3295	211	1140	34998	5153	330
1989	309	9480	1404	91	708	21731	3219	209	1107	33981	5033	327
1990	298	9161	1365	90	684	21000	3128	206	1070	32838	4892	322
1991	290	8888	1331	89	664	20373	3051	203	1038	31858	4770	318
1992	281	8635	1298	88	645	19793	2976	201	1008	30951	4654	314
1993	273	8373	1263	86	625	19193	2895	197	978	30013	4528	309
1994	266	8171	1234	85	610	18730	2830	195	954	29289	4425	305
1995	258	7924	1197	84	592	18163	2743	191	925	28402	4290	299
PV Sum (0%):	2962	90909	13546	891	6789	208387	31050	2044	10617	325865	48555	3196
PV Sum (5%):	2315	31462	10572	692	5307	72119	24235	1586	8298	112776	37897	2481

Second-Order Impacts:

Tobacco Farming Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Tobacco	$/Lb	-0.06	-4.2
Domestic Tobacco Sales	Million Lbs	-192	-21.3
Export Tobacco Sales	Million Lbs	51	8.4
Total Tobacco Revenue	Million $	-298	-13.2
Quota Lease Revenue	Million $	-85	-25.2
Producers' Surplus	Million $	-34	N.A.

Cigarette Industry Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Cigarettes	$/1000	-1.12	-3.3
Domestic Cigarettes Sales	Millions	-34929	-6.0
Export Cigarettes Sales	Millions	752	1.2
Total Cigarette Revenue (Net of Federal Excise Tax)	Million $	222	1.3

Tax & Consumer Impacts:	**Unit**	**Absolute Change**	**% Change**
Federal Excise Tax Revenue	Million $	279	6.0
Consumers' Surplus	Million $	2310	N.A.

Health Impacts:

Discount Rate	Change in Medical Costs (PV 1986 Million $)	Change in Expected Life (PV Years)
0 %	14162	-6885151
5 %	3409	-1580327

Employment Impacts by Sector (Change in Full-Time Equivalent Jobs):

Sector:	Tobacco	Cigarette	Warehouse	Support	Wholesale	Retail	TOTAL
Impact:	-4936	2368	-158	146	1801	929	249

Table C.7

Modification: Increase Percentage of Expanded Tobacco from 25 to 50%
Assumptions: Four-year Grace Period, and No Change in Domestic Cigarette Demand
Cost Impacts (%): Tobacco Content = −12.73 Paper Cost = 0.00 Other Cost = −0.58
Change in Tar and Nicotine (%): 0.0

First-Order Impacts:

Fire Impacts: Lives Saved (or Life Years Gained), Injuries Avoided,, and Property Losses (Million $) Avoided

Year	25% Fewer Fires				50% Fewer Fires				75% Fewer Fires			
	Lives	Life Years	Number Injured	Prop Loss	Lives	Life Years	Number Injured	Prop Loss	Lives	Live Years	Number Injured	Prop Loss
1986	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	359	11023	1642	108	725	22241	3313	218	1090	33459	4984	328
1991	348	10694	1601	107	703	21577	3231	215	1058	32460	4860	324
1992	338	10389	1562	105	683	20962	3152	212	1027	31536	4742	320
1993	328	10075	1520	104	662	20328	3066	209	996	30581	4613	315
1994	320	9832	1485	102	646	19837	2997	207	972	29843	4509	311
1995	311	9534	1440	101	627	19237	2906	203	943	28939	4371	305
PV Sum (0%):	2005	61547	9251	627	4046	124182	18665	1264	6086	186817	28079	1902
PV Sum (5%):	1401	19043	6462	437	2827	38423	13038	882	4253	57802	19614	1327

Second-Order Impacts:

Tobacco Farming Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Tobacco	$/Lb	−0.04	−2.7
Domestic Tobacco Sales	Million Lbs	−79	−9.6
Export Tobacco Sales	Million Lbs	29	5.4
Total Tobacco Revenue	Million $	−128	−6.2
Quota Lease Revenue	Million $	−52	−16.9
Producers' Surplus	Million $	−13	N.A.

Cigarette Industry Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Cigarettes	$/1000	−0.49	−1.5
Domestic Cigarettes Sales	Millions	2322	−0.4
Export Cigarettes Sales	Millions	436	0.7
Total Cigarette Revenue (Net of Federal Excise Tax)	Million $	−195	−1.3

Tax & Consumer Impacts:	**Unit**	**Absolute Change**	**% Change**
Federal Excise Tax Revenue	Million $	19	0.4
Consumers' Surplus	Million $	262	N.A.

Health Impacts:

Discount Rate	Change in Medical Costs (PV 1986 Million $)	Change in Expected Life (PV Years)
0 %	958	−463952
5 %	198	−91733

Employment Impacts by Sector (Change in Full-Time Equivalent Jobs):

Sector:	Tobacco	Cigarette	Warehouse	Support	Wholesale	Retail	TOTAL
Impact:	−1749	319	−56	30	147	62	−1248

Table C.8

Modification: Increase Percentage of Expanded Tobacco from 25 to 50%
Assumptions: Four-year Grace Period, and a 5.0% Decrease in Domestic Cigarette Demand
Cost Impacts (%): Tobacco Content = -12.73 Paper Cost = 0.00 Other Cost = -0.58
Change in Tar and Nicotine (%): 0.0

First-Order Impacts:

Fire Impacts: Lives Saved (or Life Years Gained), Injuries Avoided,, and Property Losses (Million $) Avoided

Year	25% Fewer Fires				50% Fewer Fires				75% Fewer Fires			
	Lives	Life Years	Number Injured	Prop Loss	Lives	Life Years	Number Injured	Prop Loss	Lives	Live Years	Number Injured	Prop Loss
1986	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	414	12692	1891	124	761	23354	3479	229	1108	34015	5067	334
1991	401	12314	1844	123	738	22657	3393	226	1075	33000	4941	330
1992	390	11963	1799	121	717	22011	3310	223	1045	32060	4821	325
1993	378	11601	1750	119	695	21345	3220	220	1013	31089	4690	320
1994	369	11321	1710	118	679	20830	3147	217	988	30339	4583	316
1995	358	10978	1658	116	658	20199	3051	213	959	29420	4444	310
PV Sum (0%):	2309	70868	10652	722	4248	130396	19599	1328	6188	189924	28546	1934
PV Sum (5%):	1613	21927	7441	503	2969	40345	13691	926	4324	58764	19941	1349

Second-Order Impacts:

Tobacco Farming Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Tobacco	$/Lb	-0.05	-3.6
Domestic Tobacco Sales	Million Lbs	-103	-12.6
Export Tobacco Sales	Million Lbs	40	7.3
Total Tobacco Revenue	Million $	-166	-6.1
Quota Lease Revenue	Million $	-70	-22.8
Producers' Surplus	Million $	-16	N.A.

Cigarette Industry Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Cigarettes	$/1000	-0.51	-1.5
Domestic Cigarettes Sales	Millions	-24203	-4.5
Export Cigarettes Sales	Millions	594	1.0
Total Cigarette Revenue (Net of Federal Excise Tax)	Million $	-873	-5.7

Tax & Consumer Impacts:	**Unit**	**Absolute Change**	**% Change**
Federal Excise Tax Revenue	Million $	-194	-4.5
Consumers' Surplus	Million $	-1232	N.A.

Health Impacts:

Discount Rate	Change in Medical Costs (PV 1986 Million $)	Change in Expected Life (PV Years)
0 %	-9758	5623657
5 %	-1881	1054693

Employment Impacts by Sector (Change in Full-Time Equivalent Jobs):

Sector:	Tobacco	Cigarette	Warehouse	Support	Wholesale	Retail	TOTAL
Impact:	-2216	-2734	-71	-255	-1258	-644	-7177

Table C.9

Modification: Increase Percentage of Expanded Tobacco from 25 to 50%
Assumptions: Four-year Grace Period, and a 5.0% Increase in Domestic Cigarette Demand
Cost Impacts (%): Tobacco Content = −12.73 Paper Cost = 0.00 Other Cost = −0.58
Change in Tar and Nicotine (%): 0.0

First-Order Impacts:

Fire Impacts: Lives Saved (or Life Years Gained), Injuries Avoided,, and Property Losses (Million $) Avoided

Year	25% Fewer Fires				50% Fewer Fires				75% Fewer Fires			
	Lives	Life Years	Number Injured	Prop Loss	Lives	Life Years	Number Injured	Prop Loss	Lives	Live Years	Number Injured	Prop Loss
1986	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	305	9354	1393	92	688	21128	3147	207	1072	32902	4901	323
1991	296	9074	1359	91	668	20497	3069	205	1040	31920	4780	319
1992	287	8816	1326	89	649	19914	2994	202	1010	31011	4663	314
1993	279	8549	1290	88	629	19310	2913	199	980	30072	4536	309
1994	272	8343	1260	87	614	18844	2847	196	956	29346	4434	306
1995	264	8090	1222	85	595	18274	2760	193	927	28458	4298	300
PV Sum (0%):	1702	52226	7850	532	3843	117968	17731	1201	5985	183710	27612	1871
PV Sum (5%):	1189	16159	5483	371	2686	36500	12386	838	4183	56841	19288	1305

Second-Order Impacts:

Tobacco Farming Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Tobacco	$/Lb	−0.03	−1.7
Domestic Tobacco Sales	Million Lbs	−55	−6.7
Export Tobacco Sales	Million Lbs	19	3.4
Total Tobacco Revenue	Million $	−89	−4.3
Quota Lease Revenue	Million $	−33	−10.8
Producers' Surplus	Million $	−9	N.A.

Cigarette Industry Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Cigarettes	$/1000	−0.47	−1.4
Domestic Cigarettes Sales	Millions	−28846	5.4
Export Cigarettes Sales	Millions	277	0.5
Total Cigarette Revenue (Net of Federal Excise Tax)	Million $	483	3.2

Tax & Consumer Impacts:	**Unit**	**Absolute Change**	**% Change**
Federal Excise Tax Revenue	Million $	231	5.4
Consumers' Surplus	Million $	1755	N.A.

Health Impacts:

Discount Rate	Change in Medical Costs (PV 1986 Million $)	Change in Expected Life (PV Years)
0 %	11909	−5764660
5 %	2461	−1139797

Employment Impacts by Sector (Change in Full-Time Equivalent Jobs):

Sector:	Tobacco	Cigarette	Warehouse	Support	Wholesale	Retail	TOTAL
Impact:	−1283	3373	−41	315	1552	767	4682

Table C.10

Modification: Increase Percentage of Expanded Tobacco from 25 to 50%
Assumptions: Immediate Implementation, and No Change in Domestic Cigarette Demand
Cost Impacts (%): Tobacco Content = -12.73 Paper Cost = 0.00 Other Cost = -0.58
Change in Tar and Nicotine (%): 0.0

First-Order Impacts:

Fire Impacts: Lives Saved (or Life Years Gained), Injuries Avoided,, and Property Losses (Million $) Avoided

Year	25% Fewer Fires				50% Fewer Fires				75% Fewer Fires			
	Lives	Life Years	Number Injured	Prop Loss	Lives	Life Years	Number Injured	Prop Loss	Lives	Live Years	Number Injured	Prop Loss
1986	409	12558	1846	113	825	25337	3725	229	1242	38117	5603	344
1987	395	12126	1783	112	797	24467	3597	226	1199	36808	5411	340
1988	383	11748	1730	111	772	23704	3490	224	1162	35660	5250	336
1989	372	11407	1690	110	750	23015	3409	221	1128	34624	5129	333
1990	359	11023	1642	108	725	22241	3313	218	1090	33459	4984	328
1991	348	10694	1601	107	703	21577	3231	215	1058	32460	4860	324
1992	338	10389	1562	105	683	20962	3152	212	1027	31536	4742	320
1993	328	10075	1520	104	662	20328	3066	209	996	30581	4613	315
1994	320	9832	1485	102	646	19837	2997	207	972	29843	4509	311
1995	311	9534	1440	101	627	19237	2906	203	943	28939	4371	305
PV Sum (0%):	3564	109386	16299	1073	7190	220705	32886	2164	10817	332024	49473	3256
PV Sum (5%):	2786	37856	12721	833	5620	76382	25667	1680	8455	114908	38614	2527

Second-Order Impacts:

Tobacco Farming Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Tobacco	$/Lb	-0.04	-2.7
Domestic Tobacco Sales	Million Lbs	-87	-9.6
Export Tobacco Sales	Million Lbs	32	5.4
Total Tobacco Revenue	Million $	-140	-6.2
Quota Lease Revenue	Million $	-57	-16.9
Producers' Surplus	Million $	-14	N.A.

Cigarette Industry Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Cigarettes	$/1000	-0.49	-1.5
Domestic Cigarettes Sales	Millions	2542	0.4
Export Cigarettes Sales	Millions	477	0.7
Total Cigarette Revenue (Net of Federal Excise Tax)	Million $	-214	-1.3

Tax & Consumer Impacts:	**Unit**	**Absolute Change**	**% Change**
Federal Excise Tax Revenue	Million $	20	0.4
Consumers' Surplus	Million $	287	N.A.

Health Impacts:

Discount Rate	Change in Medical Costs (PV 1986 Million $)	Change in Expected Life (PV Years)
0 %	1030	-501000
5 %	248	-114993

Employment Impacts by Sector (Change in Full-Time Equivalent Jobs):

Sector:	Tobacco	Cigarette	Warehouse	Support	Wholesale	Retail	TOTAL
Impact:	-1915	350	-61	33	161	68	-1366

Table C.11

Modification: Increase Percentage of Expanded Tobacco from 25 to 50%
Assumptions: Immediate Implementation, and a 5.0% Decrease in Domestic Cigarette Demand
Cost Impacts (%): Tobacco Content = -12.73 Paper Cost = 0.00 Other Cost = -0.58
Change in Tar and Nicotine (%): 0.0

First-Order Impacts:

Fire Impacts: Lives Saved (or Life Years Gained), Injuries Avoided,, and Property Losses (Million $) Avoided

Year	25% Fewer Fires				50% Fewer Fires				75% Fewer Fires			
	Lives	Life Years	Number Injured	Prop Loss	Lives	Life Years	Number Injured	Prop Loss	Lives	Live Years	Number Injured	Prop Loss
1986	471	14459	2126	131	867	26605	3911	240	1262	38751	5696	350
1987	455	13963	2053	129	837	25691	3777	237	1219	37420	5501	345
1988	441	13527	1992	128	811	24890	3665	235	1181	36253	5337	342
1989	428	13134	1946	126	787	24167	3580	233	1147	35199	5214	339
1990	414	12692	1891	124	761	23354	3479	229	1108	34015	5067	334
1991	401	12314	1844	123	738	22657	3393	226	1075	33000	4941	330
1992	390	11963	1799	121	717	22011	3310	223	1045	32060	4821	325
1993	378	11601	1750	119	695	21345	3220	220	1013	31089	4690	320
1994	369	11321	1710	118	679	20830	3147	217	988	30339	4583	316
1995	358	10978	1258	116	658	20199	3051	213	959	29420	4444	310
PV Sum (0%):	4103	125952	18767	1235	7550	231749	34531	2273	10997	337546	50295	3310
PV Sum (5%):	3207	43590	14648	959	5902	80204	26952	1764	8596	116819	39256	2570

Second-Order Impacts:

Tobacco Farming Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Tobacco	$/Lb	-0.05	-3.6
Domestic Tobacco Sales	Million Lbs	-113	-12.6
Export Tobacco Sales	Million Lbs	44	7.3
Total Tobacco Revenue	Million $	-182	-8.1
Quota Lease Revenue	Million $	-77	-22.8
Producers' Surplus	Million $	-17	N.A.

Cigarette Industry Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Cigarettes	$/1000	-0.51	-1.5
Domestic Cigarettes Sales	Millions	-26497	-4.5
Export Cigarettes Sales	Millions	650	1.0
Total Cigarette Revenue (Net of Federal Excise Tax)	Million $	-955	-5.7

Tax & Consumer Impacts:	**Unit**	**Absolute Change**	**% Change**
Federal Excise Tax Revenue	Million $	-212	-4.5
Consumers' Surplus	Million $	-1348	N.A.

Health Impacts:

Discount Rate	Change in Medical Costs (PV 1986 Million $)	Change in Expected Life (PV Years)
0 %	-10663	6143322
5 %	-2379	1330215

Employment Impacts by Sector (Change in Full-Time Equivalent Jobs):

Sector:	Tobacco	Cigarette	Warehouse	Support	Wholesale	Retail	TOTAL
Impact:	-2426	-2993	-78	-279	-1377	-705	-7858

Table C.12

Modification: Increase Percentage of Expanded Tobacco from 25 to 50%
Assumptions: Immediate Implementation, and a 5.0% Increase in Domestic Cigarette Demand
Cost Impacts (%): Tobacco Content = -12.73 Paper Cost = 0.00 Other Cost = -0.58
Change in Tar and Nicotine (%): 0.0

First-Order Impacts:

Fire Impacts: Lives Saved (or Life Years Gained), Injuries Avoided,, and Property Losses (Million $) Avoided

Year	25% Fewer Fires				50% Fewer Fires				75% Fewer Fires			
	Lives	Life Years	Number Injured	Prop Loss	Lives	Life Years	Number Injured	Prop Loss	Lives	Live Years	Number Injured	Prop Loss
1986	347	10656	1566	96	784	24069	3538	217	1221	37483	5510	339
1987	335	10290	1513	95	757	23243	3417	215	1179	36195	5321	334
1988	325	9969	1468	94	734	22518	3315	212	1142	35067	5163	333
1989	315	9679	1434	93	712	21864	3239	210	1109	34048	5043	328
1990	305	9354	1393	92	688	21128	3147	207	1072	32902	4901	323
1991	296	9074	1359	91	668	20497	3069	205	1040	31920	4780	319
1992	287	8816	1326	89	649	19914	2994	202	1010	31011	4663	314
1993	279	8549	1290	88	629	19310	2913	199	980	30072	4536	309
1994	272	8343	1260	87	614	18844	2847	196	956	29346	4434	306
1995	264	8090	1222	85	595	18274	2760	193	927	28458	4298	300
PV Sum (0%):	3024	92820	13830	910	6831	209661	31240	2056	10637	326502	48650	3202
PV Sum (5%):	2364	32123	10795	707	5339	72560	24383	1596	8315	112997	37971	2485

Second-Order Impacts:

Tobacco Farming Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Tobacco	$/Lb	-0.03	-1.7
Domestic Tobacco Sales	Million Lbs	-61	-6.7
Export Tobacco Sales	Million Lbs	20	3.4
Total Tobacco Revenue	Million $	-97	-4.3
Quota Lease Revenue	Million $	-36	-10.8
Producers' Surplus	Million $	-10	N.A.

Cigarette Industry Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Cigarettes	$/1000	-0.47	-1.4
Domestic Cigarettes Sales	Millions	31580	5.4
Export Cigarettes Sales	Millions	304	0.5
Total Cigarette Revenue (Net of Federal Excise Tax)	Million $	529	3.2

Tax & Consumer Impacts:	**Unit**	**Absolute Change**	**% Change**
Federal Excise Tax Revenue	Million $	253	5.4
Consumers' Surplus	Million $	1921	N.A.

Health Impacts:

Discount Rate	Change in Medical Costs (PV 1986 Million $)	Change in Expected Life (PV Years)
0 %	12804 - 6224985	
5 %	3083	-1428801

Employment Impacts by Sector (Change in Full-Time Equivalent Jobs):

Sector:	Tobacco	Cigarette	Warehouse	Support	Wholesale	Retail	TOTAL
Impact:	-1405	-3692	-45	345	1699	840	5126

Table C.13

Modification: Increase Paper Weight from 24 to 32 grams per square meter
Assumptions: Four-year Grace Period, and No Change in Domestic Cigarette Demand
Cost Impacts (%): Tobacco Content = 0.00 Paper Cost = 48.20 Other Cost = 0.33
Change in Tar and Nicotine (%): 0.0

First-Order Impacts:

Fire Impacts: Lives Saved (or Life Years Gained), Injuries Avoided,, and Property Losses (Million $) Avoided

Year	25% Fewer Fires				50% Fewer Fires				75% Fewer Fires			
	Lives	Life Years	Number Injured	Prop Loss	Lives	Life Years	Number Injured	Prop Loss	Lives	Live Years	Number Injured	Prop Loss
1986	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	365	11216	1671	110	729	22370	3332	219	1092	33523	4994	329
1991	355	10881	1629	109	707	21702	3250	217	1060	32523	4870	325
1992	344	10571	1590	107	687	21084	3170	214	1029	31596	4751	320
1993	334	10251	1546	105	666	20445	3084	210	998	30639	4622	315
1994	326	10004	1511	104	650	19952	3014	208	974	29900	4517	311
1995	316	9701	1465	102	630	19348	2922	204	945	28995	4379	306
PV Sum (0%):	2040	62626	9413	638	4069	124901	18773	1272	6098	187176	28134	1906
PV Sum (5%):	1426	19377	6575	445	2844	38645	13114	887	4261	57914	19652	1329

Second-Order Impacts:

Tobacco Farming Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Tobacco	$/Lb	-0.00	-0.0
Domestic Tobacco Sales	Million Lbs	-1	-0.1
Export Tobacco Sales	Million Lbs	0	0.1
Total Tobacco Revenue	Million $	-1	-0.1
Quota Lease Revenue	Million $	-1	-0.2
Producers' Surplus	Million $	-0	N.A.

Cigarette Industry Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Cigarettes	$/1000	0.16	0.5
Domestic Cigarettes Sales	Millions	-748	-0.1
Export Cigarettes Sales	Millions	5	0.0
Total Cigarette Revenue (Net of Federal Excise Tax)	Million $	65	0.4

Tax & Consumer Impacts:	**Unit**	**Absolute Change**	**% Change**
Federal Excise Tax Revenue	Million $	-6	-0.1
Consumers' Surplus	Million $	-84	N.A.

Health Impacts:

Discount Rate	Change in Medical Costs (PV 1986 Million $)	Change in Expected Life (PV Years)
0 %	-301	173716
5 %	-58	32580

Employment Impacts by Sector (Change in Full-Time Equivalent Jobs):

Sector:	Tobacco	Cigarette	Warehouse	Support	Wholesale	Retail	TOTAL
Impact:	-15	5	-0	449	-40	-20	379

Table C.14

Modification: Increase Paper Weight from 24 to 32 grams per square meter
Assumptions: Four-year Grace Period, and a 5.0% Decrease in Domestic Cigarette Demand
Cost Impacts (%): Tobacco Content = 0.00 Paper Cost = 48.20 Other Cost = 0.33
Change in Tar and Nicotine (%): 0.0

First-Order Impacts:

Fire Impacts: Lives Saved (or Life Years Gained), Injuries Avoided,, and Property Losses (Million $) Avoided

Year	25% Fewer Fires				50% Fewer Fires				75% Fewer Fires			
	Lives	Life Years	Number Injured	Prop Loss	Lives	Life Years	Number Injured	Prop Loss	Lives	Live Years	Number Injured	Prop Loss
1986	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	420	12884	1919	126	765	23481	3498	230	1110	34079	5077	334
1991	407	12499	1872	125	742	22781	3411	227	1077	33062	4951	330
1992	396	12143	1826	123	721	22132	3328	224	1046	32120	4830	326
1993	384	11775	1776	121	699	21461	3237	221	1015	31147	4699	320
1994	374	11491	1736	120	682	20944	3164	218	990	30396	4592	317
1995	363	11143	1683	117	662	20309	3068	214	960	29475	4452	311
PV Sum (0%):	2344	71936	10812	732	4271	131108	19706	1335	6199	190280	28600	1938
PV Sum (5%):	1638	22258	7553	511	2985	40566	13765	931	4332	58874	19978	1351

Second-Order Impacts:

Tobacco Farming Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Tobacco	$/Lb	-0.02	-1.1
Domestic Tobacco Sales	Million Lbs	-28	-3.4
Export Tobacco Sales	Million Lbs	13	2.3
Total Tobacco Revenue	Million $	-47	-2.3
Quota Lease Revenue	Million $	-23	-7.4
Producers' Surplus	Million $	-4	N.A.

Cigarette Industry Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Cigarettes	$/1000	0.13	0.4
Domestic Cigarettes Sales	Millions	-27243	-5.1
Export Cigarettes Sales	Millions	186	0.3
Total Cigarette Revenue (Net of Federal Excise Tax)	Million $	-632	-4.1

Tax & Consumer Impacts:	**Unit**	**Absolute Change**	**% Change**
Federal Excise Tax Revenue	Million $	-218	-5.1
Consumers' Surplus	Million $	-1566	N.A.

Health Impacts:

Discount Rate	Change in Medical Costs (PV 1986 Million $)	Change in Expected Life (PV Years)
0 %	-10984	6329962
5 %	-2117	1187158

Employment Impacts by Sector (Change in Full-Time Equivalent Jobs):

Sector:	Tobacco	Cigarette	Warehouse	Support	Wholesale	Retail	TOTAL
Impact:	-548	-3042	-18	164	-1441	-724	-5610

Table C.15

Modification: Increase Paper Weight from 24 to 32 grams per square meter
Assumptions: Four-year Grace Period, and a 5.0% Increase in Domestic Cigarette Demand
Cost Impacts (%): Tobacco Content = 0.00 Paper Cost = 48.20 Other Cost = 0.33
Change in Tar and Nicotine (%): 0.0

First-Order Impacts:

Fire Impacts: Lives Saved (or Life Years Gained), Injuries Avoided,, and Property Losses (Million $) Avoided

Year	25% Fewer Fires				50% Fewer Fires				75% Fewer Fires			
	Lives	Life Years	Number Injured	Prop Loss	Lives	Life Years	Number Injured	Prop Loss	Lives	Live Years	Number Injured	Prop Loss
1986	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	311	9549	1422	94	693	21258	3167	208	1074	32967	4911	323
1991	302	9264	1387	92	672	20624	3088	206	1042	31983	4789	319
1992	293	9000	1353	91	653	20036	3013	203	1012	31072	4672	315
1993	284	8727	1317	90	633	19429	2931	200	982	30131	4545	310
1994	277	8517	1287	89	618	18960	2864	197	958	29404	4442	306
1995	269	8259	1247	87	599	18386	2777	194	929	28514	4307	301
PV Sum (0%):	1737	53315	8013	543	3867	118694	17840	1209	5997	184073	27667	1874
PV Sum (5%)	1214	15496	5598	379	2702	36725	12462	843	4191	56953	19326	1307

Second-Order Impacts:

Tobacco Farming Impacts:	Units	Absolute Change	% Change
Price of Tobacco	$/Lb	-0.02	-1.1
Domestic Tobacco Sales	Million Lbs	27	3.2
Export Tobacco Sales	Million Lbs	-12	-2.2
Total Tobacco Revenue	Million $	45	2.2
Quota Lease Revenue	Million $	22	7.1
Producers' Surplus	Million $	4	N.A.

Cigarette Industry Impacts:	Units	Absolute Change	% Change
Price of Cigarettes	$/1000	0.18	0.5
Domestic Cigarettes Sales	Millions	25748	4.8
Export Cigarettes Sales	Millions	-176	-0.3
Total Cigarette Revenue (Net of Federal Excise Tax)	Million $	763	5.0

Tax & Consumer Impacts:	Unit	Absolute Change	% Change
Federal Excise Tax Revenue	Million $	206	4.8
Consumers' Surplus	Million $	1397	N.A.

Health Impacts:

Discount Rate	Change in Medical Costs (PV 1986 Million $)	Change in Expected Life (PV Years)
0 %	10630	-5145414
5 %	2196	-1017359

Employment Impacts by Sector (Change in Full-Time Equivalent Jobs):

Sector:	Tobacco	Cigarette	Warehouse	Support	Wholesale	Retail	TOTAL
Impact:	518	3053	17	733	1362	685	6368

Table C.16

Modification: Increase Paper Weight from 24 to 32 grams per square meter
Assumptions: Immediate Implementation, and No Change in Domestic Cigarette Demand
Cost Impacts (%): Tobacco Content = 0.00 Paper Cost = 48.20 Other Cost = 0.33
Change in Tar and Nicotine (%): 0.0

First-Order Impacts:

Fire Impacts: Lives Saved (or Life Years Gained), Injuries Avoided,, and Property Losses (Million $) Avoided

Year	25% Fewer Fires				50% Fewer Fires				75% Fewer Fires			
	Lives	Life Years	Number Injured	Prop Loss	Lives	Life Years	Number Injured	Prop Loss	Lives	Live Years	Number Injured	Prop Loss
1986	416	12778	1878	115	830	25484	3746	230	1244	38190	5614	345
1987	402	12339	1814	114	802	24609	3618	227	1201	36878	5422	340
1988	389	11954	1760	113	777	23841	3510	225	1164	35728	5260	337
1989	378	11607	1719	112	754	23148	3429	223	1130	34690	5138	334
1990	365	11216	1671	110	729	22370	3332	219	1092	33523	4994	329
1991	355	10881	1629	109	707	21702	3250	217	1060	32523	4870	325
1992	344	10571	1590	107	687	21084	3170	214	1029	31596	4751	320
1993	334	10251	1546	105	666	20445	3084	210	998	30639	4622	315
1994	326	10004	1511	104	650	19952	3014	208	974	29900	4517	311
1995	316	9701	1465	102	630	19348	2922	204	945	28995	4379	306
PV Sum (0%):	3626	111303	16584	1091	7232	221983	33076	2177	10838	332663	49568	3262
PV Sum (5%):	2834	38520	12944	847	5653	76824	25816	1690	8472	115129	38688	2532

Second-Order Impacts:

Tobacco Farming Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Tobacco	$/Lb	-0.00	-0.0
Domestic Tobacco Sales	Million Lbs	-1	-0.1
Export Tobacco Sales	Million Lbs	0	0.1
Total Tobacco Revenue	Million $	-1	-0.1
Quota Lease Revenue	Million $	-1	-0.2
Producers' Surplus	Million $	-0	N.A.

Cigarette Industry Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Cigarettes	$/1000	0.16	0.5
Domestic Cigarettes Sales	Millions	-818	-0.1
Export Cigarettes Sales	Millions	6	0.0
Total Cigarette Revenue (Net of Federal Excise Tax)	Million $	71	0.4

Tax & Consumer Impacts:	**Unit**	**Absolute Change**	**% Change**
Federal Excise Tax Revenue	Million $	-7	-0.1
Consumers' Surplus	Million $	-92	N.A.

Health Impacts:

Discount Rate	Change in Medical Costs (PV 1986 Million $)	Change in Expected Life (PV Years)
0 %	-329	189769
5 %	-73	41091

Employment Impacts by Sector (Change in Full-Time Equivalent Jobs):

Sector:	Tobacco	Cigarette	Warehouse	Support	Wholesale	Retail	TOTAL
Impact:	-16	6	-1	491	-43	-22	415

Table C.17

Modification: Increase Paper Weight from 24 to 32 grams per square meter
Assumptions: Immediate Implementation, and a 5.0% Decrease in Domestic Cigarette Demand
Cost Impacts (%): Tobacco Content = 0.00 Paper Cost = 48.20 Other Cost = 0.33
Change in Tar and Nicotine (%): 0.0

First-Order Impacts:

Fire Impacts: Lives Saved (or Life Years Gained), Injuries Avoided,, and Property Losses (Million $) Avoided

Year	25% Fewer Fires				50% Fewer Fires				75% Fewer Fires			
	Lives	Life Years	Number Injured	Prop Loss	Lives	Life Years	Number Injured	Prop Loss	Lives	Live Years	Number Injured	Prop Loss
1986	478	14677	2158	133	872	26750	3932	242	1265	38823	5707	351
1987	462	14173	2084	131	842	25832	3798	238	1221	37490	5512	346
1988	447	13731	2022	130	815	25026	3685	236	1183	36321	5347	343
1989	434	13332	1975	128	792	24299	3599	234	1149	35265	5224	339
1990	420	12884	1919	126	765	23481	3498	230	1110	34079	5077	334
1991	407	12499	1872	125	742	22781	3411	227	1077	33062	4951	330
1992	396	12143	1826	123	721	22132	3328	224	1046	32120	4830	326
1993	384	11775	1776	121	699	21461	3237	221	1015	31147	4699	320
1994	374	11491	1736	120	682	20944	3164	218	990	30396	4592	317
1995	363	11143	1683	117	662	20309	3068	214	960	29475	4452	311
PV Sum (0%):	4165	127851	19050	1254	7592	233015	34720	2285	11018	338179	50390	3316
PV Sum (5%):	3256	44247	14869	973	5934	80642	27099	1774	8612	117038	39329	2574

Second-Order Impacts:

Tobacco Farming Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Tobacco	$/Lb	-0.02	-1.1
Domestic Tobacco Sales	Million Lbs	-31	-3.4
Export Tobacco Sales	Million Lbs	14	2.3
Total Tobacco Revenue	Million $	-51	-2.3
Quota Lease Revenue	Million $	-25	-7.4
Producers' Surplus	Million $	-4	N.A.

Cigarette Industry Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Cigarettes	$/1000	0.13	0.4
Domestic Cigarettes Sales	Millions	-29824	-5.1
Export Cigarettes Sales	Millions	204	0.3
Total Cigarette Revenue (Net of Federal Excise Tax)	Million $	-692	-4.1

Tax & Consumer Impacts:	**Unit**	**Absolute Change**	**% Change**
Federal Excise Tax Revenue	Million $	-239	-5.1
Consumers' Surplus	Million $	-1714	N.A.

Health Impacts:

Discount Rate	Change in Medical Costs (PV 1986 Million $)	Change in Expected Life (PV Years)
0 %	-12002	6914895
5 %	-2678	1497284

Employment Impacts by Sector (Change in Full-Time Equivalent Jobs):

Sector:	Tobacco	Cigarette	Warehouse	Support	Wholesale	Retail	TOTAL
Impact:	-600	-3330	-19	180	-1578	-793	-6141

Table C.18

Modification: Increase Paper Weight from 24 to 32 grams per square meter
Assumptions: Immediate Implementation, and a 5.0% Increase in Domestic Cigarette Demand
Cost Impacts (%): Tobacco Content = 0.00 Paper Cost = 48.20 Other Cost = 0.33
Change in Tar and Nicotine (%): 0.0

First-Order Impacts:

Fire Impacts: Lives Saved (or Life Years Gained), Injuries Avoided,, and Property Losses (Million $) Avoided

Year	25% Fewer Fires				50% Fewer Fires				75% Fewer Fires			
	Lives	Life Years	Number Injured	Prop Loss	Lives	Life Years	Number Injured	Prop Loss	Lives	Live Years	Number Injured	Prop Loss
1986	354	10878	1599	98	789	24217	3560	219	1224	37557	5521	339
1987	342	10504	1544	97	762	23386	3438	216	1182	36267	5332	335
1988	332	10177	1498	96	738	22656	3336	214	1145	35136	5173	331
1989	322	9881	1464	95	717	21998	3258	212	1111	34115	5053	328
1990	311	9549	1422	94	693	21258	3167	208	1074	32967	4911	323
1991	302	9264	1387	92	672	20624	3088	206	1042	31983	4789	319
1992	293	9000	1353	91	653	20036	3013	203	1012	31072	4672	315
1993	284	8727	1317	90	633	19429	2931	200	982	30131	4545	310
1994	277	8517	1287	89	618	18960	2864	197	958	29404	4442	306
1995	269	8259	1247	87	599	18386	2777	194	929	28514	4307	301
PV Sum (0%):	3087	94755	14119	929	6873	210951	31432	2069	10658	327147	48746	3208
PV Sum (5%):	2413	32793	11020	721	5372	73006	24533	1606	8331	113220	38046	2490

Second-Order Impacts:

Tobacco Farming Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Tobacco	$/Lb	-0.02	-1.1
Domestic Tobacco Sales	Million Lbs	29	3.2
Export Tobacco Sales	Million Lbs	-13	-2.2
Total Tobacco Revenue	Million $	49	2.2
Quota Lease Revenue	Million $	24	7.1
Producers' Surplus	Million $	4	N.A.

Cigarette Industry Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Cigarettes	$/1000	0.18	0.5
Domestic Cigarettes Sales	Millions	28187	4.8
Export Cigarettes Sales	Millions	-193	-0.3
Total Cigarette Revenue (Net of Federal Excise Tax)	Million $	835	5.0

Tax & Consumer Impacts:	**Unit**	**Absolute Change**	**% Change**
Federal Excise Tax Revenue	Million $	225	4.8
Consumers' Surplus	Million $	1529	N.A.

Health Impacts:

Discount Rate	Change in Medical Costs (PV 1986 Million $)	Change in Expected Life (PV Years)
0 %	11428	-5556291
5 %	2751	-1275318

Employment Impacts by Sector (Change in Full-Time Equivalent Jobs):

Sector:	Tobacco	Cigarette	Warehouse	Support	Wholesale	Retail	TOTAL
Impact:	567	3342	18	803	1491	750	6971

Table C.19

Modification: Decrease Paper Porosity from 35 to 10 Coresta Units
Assumptions: Four-year Grace Period, and No Change in Domestic Cigarette Demand
Cost Impacts (%): Tobacco Content = 0.00 Paper Cost = 0.00 Other Cost = 0.00
Change in Tar and Nicotine (%): 0.0

First-Order Impacts:

Fire Impacts: Lives Saved (or Life Years Gained), Injuries Avoided,, and Property Losses (Million $) Avoided

Year	25% Fewer Fires				50% Fewer Fires				75% Fewer Fires			
	Lives	Life Years	Number Injured	Prop Loss	Lives	Life Years	Number Injured	Prop Loss	Lives	Live Years	Number Injured	Prop Loss
1986	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	364	11169	1664	110	728	22338	3328	219	1092	33508	4992	329
1991	353	10836	1623	108	706	21672	3245	216	1059	32507	4868	325
1992	343	10527	1583	107	686	21054	3166	213	1029	31581	4749	320
1993	333	10208	1540	105	665	20417	3080	210	998	30625	4620	315
1994	325	9962	1505	104	649	19924	3010	208	974	29886	4515	311
1995	315	9660	1459	102	629	19321	2918	204	944	28981	4377	306
PV Sum (0%):	2032	62363	9373	635	4064	124726	18747	1270	6095	187089	28120	1905
PV Sum (5%):	1420	19296	6548	443	2840	38591	13095	886	4259	57887	19643	1329

Second-Order Impacts:

Tobacco Farming Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Tobacco	$/Lb	-0.00	-1.1
Domestic Tobacco Sales	Million Lbs	0	0.0
Export Tobacco Sales	Million Lbs	0	0.0
Total Tobacco Revenue	Million $	0	0.0
Quota Lease Revenue	Million $	0	0.0
Producers' Surplus	Million $	0	N.A.

Cigarette Industry Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Cigarettes	$/1000	0.00	0.0
Domestic Cigarettes Sales	Millions	0	0.0
Export Cigarettes Sales	Millions	0	0.0
Total Cigarette Revenue (Net of Federal Excise Tax)	Million $	0	0.0

Tax & Consumer Impacts:	**Unit**	**Absolute Change**	**% Change**
Federal Excise Tax Revenue	Million $	0	0.0
Consumers' Surplus	Million $	0	N.A.

Health Impacts:

Discount Rate	Change in Medical Costs (PV 1986 Million $)	Change in Expected Life (PV Years)
0 %	0	0
5 %	0	0

Employment Impacts by Sector (Change in Full-Time Equivalent Jobs):

Sector:	Tobacco	Cigarette	Warehouse	Support	Wholesale	Retail	TOTAL
Impact:	0	0	0	0	0	0	0

Table C.20

Modification: Decrease Paper Porosity from 35 to 10 Coresta Units
Assumptions: Four-year Grace Period, and a 5.0% Decrease in Domestic Cigarette Demand
Cost Impacts (%): Tobacco Content = 0.00 Paper Cost = 0.00 Other Cost = 0.00
Change in Tar and Nicotine (%): 0.0

First-Order Impacts:

Fire Impacts: Lives Saved (or Life Years Gained), Injuries Avoided,, and Property Losses (Million $) Avoided

Year	25% Fewer Fires				50% Fewer Fires				75% Fewer Fires			
	Lives	Life Years	Number Injured	Prop Loss	Lives	Life Years	Number Injured	Prop Loss	Lives	Live Years	Number Injured	Prop Loss
1986	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	418	12837	1912	126	764	23450	3493	230	1110	34063	5074	334
1991	406	12454	1865	124	741	22750	3407	227	1077	33047	4948	330
1992	394	12099	1819	123	720	22102	3324	224	1046	32105	4828	325
1993	382	11732	1770	121	698	21433	3233	220	1014	31133	4696	320
1994	373	11449	1730	119	681	20916	3160	218	990	30382	4590	316
1995	362	11103	1677	117	661	20282	3063	214	960	29462	4450	311
PV Sum (0%):	2335	71674	10773	730	4266	130933	19680	1333	6196	190192	28587	1937
PV Sum (5%):	1632	22176	7525	509	2981	40512	13747	930	4330	58847	19969	1351

Second-Order Impacts:

Tobacco Farming Impacts:	Units	Absolute Change	% Change
Price of Tobacco	$/Lb	-0.02	-1.1
Domestic Tobacco Sales	Million Lbs	-27	-3.3
Export Tobacco Sales	Million Lbs	12	2.2
Total Tobacco Revenue	Million $	-45	-2.2
Quota Lease Revenue	Million $	-22	-7.2
Producers' Surplus	Million $	-4	N.A.

Cigarette Industry Impacts:	Units	Absolute Change	% Change
Price of Cigarettes	$/1000	-0.03	-0.1
Domestic Cigarettes Sales	Millions	-26495	-5.0
Export Cigarettes Sales	Millions	181	0.3
Total Cigarette Revenue (Net of Federal Excise Tax)	Million $	-692	-4.5

Tax & Consumer Impacts:	Unit	Absolute Change	% Change
Federal Excise Tax Revenue	Million $	-212	-5.0
Consumers' Surplus	Million $	-1484	N.A.

Health Impacts:

Discount Rate	Change in Medical Costs (PV 1986 Million $)	Change in Expected Life (PV Years)
0 %	-10682	6156246
5 %	-2059	1154578

Employment Impacts by Sector (Change in Full-Time Equivalent Jobs):

Sector:	Tobacco	Cigarette	Warehouse	Support	Wholesale	Retail	TOTAL
Impact:	-533	-3047	-17	-284	-1402	-705	-5989

Table C.21

Modification: Decrease Paper Porosity from 35 to 10 Coresta Units
Assumptions: Four-year Grace Period, and a 5.0% Increase in Domestic Cigarette Demand
Cost Impacts (%): Tobacco Content = 0.00 Paper Cost = 0.00 Other Cost = 0.00
Change in Tar and Nicotine (%): 0.0

First-Order Impacts:

Fire Impacts: Lives Saved (or Life Years Gained), Injuries Avoided,, and Property Losses (Million $) Avoided

Year	25% Fewer Fires				50% Fewer Fires				75% Fewer Fires			
	Lives	Life Years	Number Injured	Prop Loss	Lives	Life Years	Number Injured	Prop Loss	Lives	Live Years	Number Injured	Prop Loss
1986	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	310	9502	1415	93	692	21227	3162	208	1074	32952	4909	323
1991	300	9218	1380	92	671	20593	3084	206	1042	31968	4787	319
1992	292	8955	1347	91	652	20006	3008	203	1012	31058	4670	315
1993	283	8684	1310	89	632	19401	2927	200	981	30117	4543	310
1994	276	8475	1280	88	617	18932	2860	197	958	29390	4440	306
1995	268	8218	1241	87	598	18359	2773	194	929	28500	4305	300
PV Sum (0%):	1728	53052	7974	540	3861	118519	17814	1207	5994	183985	27654	1873
PV Sum (5%):	1208	16415	5570	377	2698	36670	12444	842	4189	56926	19317	1307

Second-Order Impacts:

Tobacco Farming Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Tobacco	$/Lb	-0.02	-1.1
Domestic Tobacco Sales	Million Lbs	-27	-3.3
Export Tobacco Sales	Million Lbs	-12	-2.2
Total Tobacco Revenue	Million $	46	2.2
Quota Lease Revenue	Million $	23	7.3
Producers' Surplus	Million $	4	N.A.

Cigarette Industry Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Cigarettes	$/1000	-0.03	-0.1
Domestic Cigarettes Sales	Millions	-26495	-5.0
Export Cigarettes Sales	Millions	-181	-0.3
Total Cigarette Revenue (Net of Federal Excise Tax)	Million $	694	4.6

Tax & Consumer Impacts:	**Unit**	**Absolute Change**	**% Change**
Federal Excise Tax Revenue	Million $	212	5.0
Consumers' Surplus	Million $	1483	N.A.

Health Impacts:

Discount Rate	Change in Medical Costs (PV 1986 Million $)	Change in Expected Life (PV Years)
0 %	10939	-5294823
5 %	2260	-1046900

Employment Impacts by Sector (Change in Full-Time Equivalent Jobs):

Sector:	Tobacco	Cigarette	Warehouse	Support	Wholesale	Retail	TOTAL
Impact:	533	3047	17	284	1402	705	5989

Table C.22

Modification: Decrease Paper Porosity from 35 to 10 Coresta Units
Assumptions: Immediate Implementation, and No Change in Domestic Cigarette Demand
Cost Impacts (%): Tobacco Content = 0.00 Paper Cost = 0.00 Other Cost = 0.00
Change in Tar and Nicotine (%): 0.0

First-Order Impacts:

Fire Impacts: Lives Saved (or Life Years Gained), Injuries Avoided,, and Property Losses (Million $) Avoided

Year	25% Fewer Fires				50% Fewer Fires				75% Fewer Fires			
	Lives	Life Years	Number Injured	Prop Loss	Lives	Life Years	Number Injured	Prop Loss	Lives	Live Years	Number Injured	Prop Loss
1986	415	12724	1870	115	829	25448	3741	230	1244	38172	5611	345
1987	400	12287	1806	113	801	24574	3613	227	1201	36861	5419	340
1988	388	11904	1753	112	776	23808	3505	225	1163	35712	5258	337
1989	377	11558	1712	111	753	23116	3424	222	1130	34674	5136	334
1990	364	11169	1664	110	728	22338	3328	219	1092	33508	4992	329
1991	353	10836	1623	108	706	21672	3245	216	1059	32507	4868	325
1992	343	10527	1583	107	686	21054	3166	213	1029	31581	4749	320
1993	333	10208	1540	105	665	20417	3080	210	998	30625	4620	315
1994	325	9962	1505	104	649	19924	3010	208	974	29886	4515	311
1995	315	9660	1459	102	629	19321	2918	204	944	28981	4377	306
PV Sum (0%):	3611	110836	16515	1087	7222	221672	33030	2174	10833	332508	49545	3261
PV Sum (5%):	2823	38358	12890	844	5645	76717	25780	1687	8468	115075	38670	2531

Second-Order Impacts:

Tobacco Farming Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Tobacco	$/Lb	0.00	0.0
Domestic Tobacco Sales	Million Lbs	0	0.0
Export Tobacco Sales	Million Lbs	0	0.0
Total Tobacco Revenue	Million $	0	0.0
Quota Lease Revenue	Million $	0	0.0
Producers' Surplus	Million $	0	N.A.

Cigarette Industry Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Cigarettes	$/1000	0.00	0.0
Domestic Cigarettes Sales	Millions	0	0.0
Export Cigarettes Sales	Millions	0	0.0
Total Cigarette Revenue (Net of Federal Excise Tax)	Million $	0	0.0

Tax & Consumer Impacts:	**Unit**	**Absolute Change**	**% Change**
Federal Excise Tax Revenue	Million $	0	0.0
Consumers' Surplus	Million $	0	N.A.

Health Impacts:

Discount Rate	Change in Medical Costs (PV 1986 Million $)	Change in Expected Life (PV Years)
0 %	0	0
5 %	0	0

Employment Impacts by Sector (Change in Full-Time Equivalent Jobs):

Sector:	Tobacco	Cigarette	Warehouse	Support	Wholesale	Retail	TOTAL
Impact:	0	0	0	0	0	0	0

Table C. 23

Modification: Decrease Paper Porosity from 35 to 10 Coresta Units
Assumptions: Immediate Implementation, and a 5.0% Decrease in Domestic Cigarette Demand
Cost Impacts (%): Tobacco Content = 0.00 Paper Cost = 0.00 Other Cost = 0.00
Change in Tar and Nicotine (%): 0.0

First-Order Impacts:

Fire Impacts: Lives Saved (or Life Years Gained), Injuries Avoided,, and Property Losses (Million $) Avoided

Year	25% Fewer Fires				50% Fewer Fires				75% Fewer Fires			
	Lives	Life Years	Number Injured	Prop Loss	Lives	Life Years	Number Injured	Prop Loss	Lives	Live Years	Number Injured	Prop Loss
1986	476	14624	2150	132	870	26715	3927	241	1264	38805	5705	351
1987	460	14122	2076	130	840	25797	3793	238	1221	37473	5509	346
1988	446	13681	2014	129	814	24993	3680	236	1183	36304	5345	342
1989	433	13284	1968	128	791	24266	3594	233	1148	35249	5221	339
1990	418	12837	1912	126	764	23450	3493	230	1110	34063	5074	334
1991	406	12454	1865	124	741	22750	3407	227	1077	33047	4948	330
1992	394	12099	1819	123	720	22102	3324	224	1046	32105	4828	325
1993	382	11732	1770	121	698	21433	3233	220	1014	31133	4696	320
1994	373	11449	1730	119	681	20916	3160	218	990	30382	4590	316
1995	362	11103	1677	117	661	20282	3063	214	960	29462	4450	311
PV Sum (0%):	4150	127384	18981	1249	7581	232704	34674	2282	11013	338024	50367	3315
PV Sum (5%):	3244	44085	14814	970	5926	80535	27063	1771	8608	116984	39311	2573

Second-Order Impacts:

Tobacco Farming Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Tobacco	$/Lb	-0.02	-1.1
Domestic Tobacco Sales	Million Lbs	-30	-3.3
Export Tobacco Sales	Million Lbs	13	2.2
Total Tobacco Revenue	Million $	-50	-2.2
Quota Lease Revenue	Million $	-24	-7.2
Producers' Surplus	Million $	-4	N.A.

Cigarette Industry Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Cigarettes	$/1000	-0.03	-0.1
Domestic Cigarettes Sales	Millions	-29006	-5.0
Export Cigarettes Sales	Millions	198	0.3
Total Cigarette Revenue (Net of Federal Excise Tax)	Million $	-758	-4.5

Tax & Consumer Impacts:	**Unit**	**Absolute Change**	**% Change**
Federal Excise Tax Revenue	Million $	-232	-5.0
Consumers' Surplus	Million $	-1624	N.A.

Health Impacts:

Discount Rate	Change in Medical Costs (PV 1986 Million $)	Change in Expected Life (PV Years)
0 %	-11673	6725126
5 %	-2605	1456193

Employment Impacts by Sector (Change in Full-Time Equivalent Jobs):

Sector:	Tobacco	Cigarette	Warehouse	Support	Wholesale	Retail	TOTAL
Impact:	-584	-3336	-19	-311	-1535	-771	-6556

Table C. 24

Modification: Decrease Paper Porosity from 35 to 10 Coresta Units
Assumptions: Immediate Implementation, and a 5.0% Increase in Domestic Cigarette Demand
Cost Impacts (%): Tobacco Content = 0.00 Paper Cost = 0.00 Other Cost = 0.00
Change in Tar and Nicotine (%): 0.0

First-Order Impacts:

Fire Impacts: Lives Saved (or Life Years Gained), Injuries Avoided,, and Property Losses (Million $) Avoided

Year	25% Fewer Fires				50% Fewer Fires				75% Fewer Fires			
	Lives	Life Years	Number Injured	Prop Loss	Lives	Life Years	Number Injured	Prop Loss	Lives	Live Years	Number Injured	Prop Loss
1986	353	10824	1591	98	788	24182	3555	218	1223	37539	5518	339
1987	341	10453	1537	97	761	23351	3433	216	1181	36250	5329	335
1988	330	10127	1491	96	737	22623	3331	213	1144	35119	5171	331
1989	320	9832	1456	95	716	21966	3254	211	1111	34099	5051	328
1990	310	9502	1415	93	692	21227	3162	208	1074	32952	4909	323
1991	300	9218	1380	92	671	20593	3084	206	1042	31968	4787	319
1992	292	8955	1347	91	652	20006	3008	203	1012	31058	4670	315
1993	283	8684	1310	89	632	19401	2927	200	981	30117	4543	310
1994	276	8475	1280	88	617	18932	2860	197	958	29390	4440	306
1995	268	8218	1241	87	598	18359	2773	194	929	28500	4305	300
PV Sum (0%):	3072	94288	14049	925	6863	210640	31386	2066	10653	326992	48723	3207
PV Sum (5%):	2401	32631	10965	718	5364	72899	24497	1603	8327	113166	38028	2489

Second-Order Impacts:

Tobacco Farming Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Tobacco	$/Lb	0.02	1.1
Domestic Tobacco Sales	Million Lbs	30	3.3
Export Tobacco Sales	Million Lbs	-13	-2.2
Total Tobacco Revenue	Million $	50	2.2
Quota Lease Revenue	Million $	25	7.3
Producers' Surplus	Million $	4	N.A.

Cigarette Industry Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Cigarettes	$/1000	0.03	0.1
Domestic Cigarettes Sales	Millions	29006	5.0
Export Cigarettes Sales	Millions	-198	-0.3
Total Cigarette Revenue (Net of Federal Excise Tax)	Million $	760	4.6

Tax & Consumer Impacts:	**Unit**	**Absolute Change**	**% Change**
Federal Excise Tax Revenue	Million $	232	5.0
Consumers' Surplus	Million $	1624	N.A.

Health Impacts:

Discount Rate	Change in Medical Costs (PV 1986 Million $)	Change in Expected Life (PV Years)
0 %	11760	-5717630
5 %	2831	-1312350

Employment Impacts by Sector (Change in Full-Time Equivalent Jobs):

Sector:	Tobacco	Cigarette	Warehouse	Support	Wholesale	Retail	TOTAL
Impact:	584	3336	19	311	1535	771	6556

Table C. 25

Modification: Add Chemical to Tobacco Blend
Assumptions: Four-year Grace Period, and No Change in Domestic Cigarette Demand
Cost Impacts (%): Tobacco Content = 0.00 Paper Cost = 0.00 Other Cost = 2.83
Change in Tar and Nicotine (%): 0.0

First-Order Impacts:

Fire Impacts: Lives Saved (or Life Years Gained), Injuries Avoided,, and Property Losses (Million $) Avoided

Year	25% Fewer Fires				50% Fewer Fires				75% Fewer Fires			
	Lives	Life Years	Number Injured	Prop Loss	Lives	Life Years	Number Injured	Prop Loss	Lives	Live Years	Number Injured	Prop Loss
1986	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	370	11364	1693	111	732	22468	3347	220	1094	33573	5001	329
1991	359	11025	1651	110	710	21798	3264	218	1061	32570	4877	325
1992	349	10711	1611	109	690	21177	3184	215	1031	31643	4758	321
1993	338	10386	1567	107	669	20535	3098	211	1000	30684	4629	316
1994	330	10136	1531	106	653	20040	3028	209	976	29944	4524	312
1995	320	9829	1485	104	633	19433	2935	205	946	29037	4386	306
PV Sum (0%):	2067	63451	9537	646	4087	125451	18856	1277	6107	187451	28175	1909
PV Sum (5%):	1445	19632	6662	451	2856	38815	13171	891	4268	57999	19681	1331

Second-Order Impacts:

Tobacco Farming Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Tobacco	$/Lb	-0.00	-0.1
Domestic Tobacco Sales	Million Lbs	-3	-0.4
Export Tobacco Sales	Million Lbs	1	0.3
Total Tobacco Revenue	Million $	-5	-0.3
Quota Lease Revenue	Million $	-3	-0.8
Producers' Surplus	Million $	-0	N.A.

Cigarette Industry Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Cigarettes	$/1000	0.65	1.9
Domestic Cigarettes Sales	Millions	-3095	-0.6
Export Cigarettes Sales	Millions	21	0.0
Total Cigarette Revenue (Net of Federal Excise Tax)	Million $	267	1.8

Tax & Consumer Impacts:	**Unit**	**Absolute Change**	**% Change**
Federal Excise Tax Revenue	Million $	-25	-0.6
Consumers' Surplus	Million $	-347	N.A.

Health Impacts:

Discount Rate	Change in Medical Costs (PV 1986 Million $)	Change in Expected Life (PV Years)
0 %	-1248	719149
5 %	241	134873

Employment Impacts by Sector (Change in Full-Time Equivalent Jobs):

Sector:	Tobacco	Cigarette	Warehouse	Support	Wholesale	Retail	TOTAL
Impact:	-62	-205	-2	81	-164	-82	-435

Table C. 26

Modification: Add Chemical to Tobacco Blend
Assumptions: Four-year Grace Period, and a 5.0% Decrease in Domestic Cigarette Demand
Cost Impacts (%): Tobacco Content = 0.00 Paper Cost = 0.00 Other Cost = 2.83
Change in Tar and Nicotine (%): 0.0

First-Order Impacts:

Fire Impacts: Lives Saved (or Life Years Gained), Injuries Avoided,, and Property Losses (Million $) Avoided

Year	25% Fewer Fires				50% Fewer Fires				75% Fewer Fires			
	Lives	Life Years	Number Injured	Prop Loss	Lives	Life Years	Number Injured	Prop Loss	Lives	Live Years	Number Injured	Prop Loss
1986	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	425	13032	1941	128	768	23580	3513	231	1112	34128	5084	335
1991	412	12643	1893	126	745	22876	3425	228	1079	33110	4958	331
1992	400	12282	1847	124	724	22224	3342	225	1048	32167	4837	326
1993	388	11910	1797	122	702	21551	3251	222	1016	31192	4705	321
1994	379	11623	1756	121	685	21031	3177	219	992	30440	4599	317
1995	367	11271	1702	119	664	20395	3080	215	962	29518	4458	311
PV Sum (0%):	2371	72761	10936	741	4289	131658	19789	1341	6208	190555	28641	1940
PV Sum (5%):	1657	22513	7639	517	2997	40736	13823	935	4338	58959	20007	1353

Second-Order Impacts:

Tobacco Farming Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Tobacco	$/Lb	-0.02	-1.2
Domestic Tobacco Sales	Million Lbs	-31	-3.7
Export Tobacco Sales	Million Lbs	14	2.5
Total Tobacco Revenue	Million $	-51	-2.5
Quota Lease Revenue	Million $	-25	-8.0
Producers' Surplus	Million $	-4	N.A.

Cigarette Industry Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Cigarettes	$/1000	0.63	1.9
Domestic Cigarettes Sales	Millions	-29590	-5.6
Export Cigarettes Sales	Millions	202	0.3
Total Cigarette Revenue (Net of Federal Excise Tax)	Million $	-443	-2.9

Tax & Consumer Impacts:	**Unit**	**Absolute Change**	**% Change**
Federal Excise Tax Revenue	Million $	-237	-5.6
Consumers' Surplus	Million $	-1822	N.A.

Health Impacts:

Discount Rate	Change in Medical Costs (PV 1986 Million $)	Change in Expected Life (PV Years)
0 %	-11930	6875395
5 %	-2299	1289451

Employment Impacts by Sector (Change in Full-Time Equivalent Jobs):

Sector:	Tobacco	Cigarette	Warehouse	Support	Wholesale	Retail	TOTAL
Impact:	-596	-3253	-19	-203	-1566	-787	-6423

Table C. 27

Modification: Add Chemical to Tobacco Blend
Assumptions: Four-year Grace Period, and a 5.0% Increase in Domestic Cigarette Demand
Cost Impacts (%): Tobacco Content = 0.00 Paper Cost = 0.00 Other Cost = 2.83
Change in Tar and Nicotine (%): 0.0

First-Order Impacts:

Fire Impacts: Lives Saved (or Life Years Gained), Injuries Avoided,, and Property Losses (Million $) Avoided

Year	25% Fewer Fires				50% Fewer Fires				75% Fewer Fires			
	Lives	Life Years	Number Injured	Prop Loss	Lives	Life Years	Number Injured	Prop Loss	Lives	Live Years	Number Injured	Prop Loss
1986	0	0	0	0	0	0	0	0	0	0	0	0
1987	0	0	0	0	0	0	0	0	0	0	0	0
1988	0	0	0	0	0	0	0	0	0	0	0	0
1989	0	0	0	0	0	0	0	0	0	0	0	0
1990	316	9696	1444	95	696	21357	3181	209	1076	33017	4918	324
1991	306	9407	1409	94	675	20719	3102	207	1044	32031	4796	320
1992	298	9139	1374	93	656	20129	3027	204	1014	31119	4679	315
1993	289	8862	1337	91	636	19519	2945	201	983	30176	4552	310
1994	282	8648	1307	90	621	19048	2878	198	959	29448	4449	307
1995	273	8387	1267	88	602	18472	2790	195	930	28557	4313	301
PV Sum (0%):	1764	54140	8137	551	3885	119244	17923	1214	6006	184348	27708	1877
PV Sum (5%):	1233	16751	5684	384	2715	36895	12520	847	4197	57038	19355	1309

Second-Order Impacts:

Tobacco Farming Impacts:		Units	Absolute Change	% Change
Price of Tobacco		$/Lb	0.01	1.0
Domestic Tobacco Sales	2.9	Million Lbs	24	
Export Tobacco Sales	-2.0	Million Lbs	-11	
Total Tobacco Revenue	2.0	Million $	41	
Quota Lease Revenue	6.5	Million $	20	
Producers' Surplus	N.A.	Million $	3	

Cigarette Industry Impacts:		Units	Absolute Change	% Change
Price of Cigarettes	2.0	$/1000	0.68	
Domestic Cigarettes Sales	4.4	Millions	23400	
Export Cigarettes Sales	-0.3	Millions	-160	
Total Cigarette Revenue (Net of Federal Excise Tax)	6.4	Million $	978	

Tax & Consumer Impacts:		Unit	Absolute Change	% Change
Federal Excise Tax Revenue	4.4	Million $	187	
Consumers' Surplus	N.A.	Million $	127	

Health Impacts:

Discount Rate	Change in Medical Costs (PV 1986 Million $)	Change in Expected Life (PV Years)
0 %	9661	-4676302
5 %	1996	-924605

Employment Impacts by Sector (Change in Full-Time Equivalent Jobs):

Sector:	Tobacco	Cigarette	Warehouse	Support	Wholesale	Retail	TOTAL
Impact:	471	2842	15	365	1238	622	5554

Table C. 28

Modification: Add Chemical to Tobacco Blend
Assumptions: Immediate Implementation, and No Change in Domestic Cigarette Demand
Cost Impacts (%): Tobacco Content = 0.00 Paper Cost = 0.00 Other Cost = 2.83
Change in Tar and Nicotine (%): 0.0

First-Order Impacts:

Fire Impacts: Lives Saved (or Life Years Gained), Injuries Avoided,, and Property Losses (Million $) Avoided

Year	25% Fewer Fires				50% Fewer Fires				75% Fewer Fires			
	Lives	Life Years	Number Injured	Prop Loss	Lives	Life Years	Number Injured	Prop Loss	Lives	Live Years	Number Injured	Prop Loss
1986	422	12946	1903	117	834	25596	3763	231	1246	38246	5622	346
1987	407	12501	1838	115	805	24717	3634	228	1203	36933	5430	341
1988	395	12112	1783	114	780	23946	3526	226	1166	35781	5268	337
1989	383	11760	1742	113	757	23250	3444	224	1132	34741	5146	334
1990	370	11364	1693	111	732	22468	3347	220	1094	33573	5001	329
1991	359	11025	1651	110	710	21798	3264	218	1061	32570	4877	325
1992	349	10711	1611	109	690	21177	3184	215	1031	31643	4758	321
1993	338	10386	1567	107	669	20535	3098	211	1000	30684	4629	316
1994	330	10136	1531	106	653	20040	3028	209	976	29944	4524	312
1995	320	9829	1485	104	633	19433	2935	205	946	29037	4386	306
PV Sum (0%):	3674	112769	16803	1106	7264	222960	33222	2186	10854	333152	49641	3267
PV Sum (5%):	2872	39027	13115	858	5678	77163	25930	1697	8484	115298	38745	2536

Second-Order Impacts:

Tobacco Farming Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Tobacco	$/Lb	-0.00	-1.0
Domestic Tobacco Sales	Million Lbs	-4	-0.4
Export Tobacco Sales	Million Lbs	2	0.3
Total Tobacco Revenue	Million $	-6	-0.3
Quota Lease Revenue	Million $	-3	-0.8
Producers' Surplus	Million $	-0	N.A.

Cigarette Industry Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Cigarettes	$/1000	0.65	1.9
Domestic Cigarettes Sales	Millions	-3388	-0.6
Export Cigarettes Sales	Millions	23	0.0
Total Cigarette Revenue (Net of Federal Excise Tax)	Million $	292	1.8

Tax & Consumer Impacts:	**Unit**	**Absolute Change**	**% Change**
Federal Excise Tax Revenue	Million $	-27	-0.6
Consumers' Surplus	Million $	-380	N.A.

Health Impacts:

Discount Rate	Change in Medical Costs (PV 1986 Million $)	Change in Expected Life (PV Years)
0 %	-1364	785603
5 %	-304	170107

Employment Impacts by Sector (Change in Full-Time Equivalent Jobs):

Sector:	Tobacco	Cigarette	Warehouse	Support	Wholesale	Retail	TOTAL
Impact:	-68	-225	-2	89	-179	-90	-476

Table C. 29

Modification: Add Chemical to Tobacco Blend
Assumptions: Immediate Implementation, and a 5.0 % Decrease in Domestic Cigarette Demand
Cost Impacts (%): Tobacco Content = 0.00 Paper Cost = 0.00 Other Cost = 2.83
Change in Tar and Nicotine (%): 0.0

First-Order Impacts:

Fire Impacts: Lives Saved (or Life Years Gained), Injuries Avoided,, and Property Losses (Million $) Avoided

Year	25% Fewer Fires				50% Fewer Fires				75% Fewer Fires			
	Lives	Life Years	Number Injured	Prop Loss	Lives	Life Years	Number Injured	Prop Loss	Lives	Live Years	Number Injured	Prop Loss
1986	484	14846	2182	134	875	26862	3949	243	1267	38879	5715	351
1987	467	14336	2108	132	845	25940	3814	239	1223	37544	5519	347
1988	452	13889	2045	131	819	25131	3700	237	1185	36373	5355	343
1989	439	13485	1997	130	795	24401	3614	235	1151	35316	5231	340
1990	425	13032	1941	128	768	23580	3513	231	1112	34128	5084	335
1991	412	12643	1893	126	745	22876	3425	228	1079	33110	4958	331
1992	400	12282	1847	124	724	22224	3342	225	1048	32167	4837	326
1993	388	11910	1797	122	702	21551	3251	222	1016	31192	4705	321
1994	379	11623	1756	121	685	21031	3177	219	992	30440	4599	317
1995	367	11271	1702	119	664	20395	3080	215	962	29518	4458	311
PV Sum (0%):	4213	129317	19269	1268	7623	233992	34866	2295	11034	338668	50463	3321
PV Sum (5%):	3293	44754	15039	984	5959	80981	27213	1781	8624	117207	39386	2578

Second-Order Impacts:

Tobacco Farming Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Tobacco	$/Lb	-0.02	-1.2
Domestic Tobacco Sales	Million Lbs	-34	-3.7
Export Tobacco Sales	Million Lbs	15	2.5
Total Tobacco Revenue	Million $	-56	-2.5
Quota Lease Revenue	Million $	-27	-8.0
Producers' Surplus	Million $	-5	N.A.

Cigarette Industry Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Cigarettes	$/1000	0.63	1.9
Domestic Cigarettes Sales	Millions	-32394	-5.6
Export Cigarettes Sales	Millions	221	0.3
Total Cigarette Revenue (Net of Federal Excise Tax)	Million $	-485	2.9

Tax & Consumer Impacts:	**Unit**	**Absolute Change**	**% Change**
Federal Excise Tax Revenue	Million $	-259	-5.6
Consumers' Surplus	Million $	-1995	N.A.

Health Impacts:

Discount Rate	Change in Medical Costs (PV 1986 Million $)	Change in Expected Life (PV Years)
0 %	-13036	7510729
5 %	-2909	1626300

Employment Impacts by Sector (Change in Full-Time Equivalent Jobs):

Sector:	Tobacco	Cigarette	Warehouse	Support	Wholesale	Retail	TOTAL
Impact:	-652	-3561	-21	-223	-1714	-861	-7032

Table C. 30

Modification: Add Chemical to Tobacco Blend
Assumptions: Immediate Implementation, and a 5.0 % Increase in Domestic Cigarette Demand
Cost Impacts (%): Tobacco Content = 0.00 Paper Cost = 0.00 Other Cost = 2.83
Change in Tar and Nicotine (%): 0.0

First-Order Impacts:

Fire Impacts: Lives Saved (or Life Years Gained), Injuries Avoided,, and Property Losses (Million $) Avoided

Year	25% Fewer Fires				50% Fewer Fires				75% Fewer Fires			
	Lives	Life Years	Number Injured	Prop Loss	Lives	Life Years	Number Injured	Prop Loss	Lives	Live Years	Number Injured	Prop Loss
1986	360	11046	1624	100	793	24330	3577	220	1225	37613	5529	340
1987	348	10667	1568	98	765	23494	3454	217	1183	36321	5340	335
1988	337	10334	1522	97	742	22761	3351	215	1146	35189	5181	332
1989	327	10034	1486	97	720	22100	3274	213	1113	34166	5061	329
1990	316	9696	1444	95	696	21357	3181	209	1076	33017	4918	324
1991	306	9407	1409	94	675	20719	3102	207	1044	32031	4796	320
1992	298	9139	1374	93	656	20129	3027	204	1014	31119	4679	315
1993	289	8862	1337	91	636	19519	2945	201	983	30176	4552	310
1994	282	8648	1307	90	621	19048	2878	198	959	29448	4449	307
1995	273	8387	1267	88	602	18472	2790	195	930	28557	4313	301
PV Sum (0%):	3135	96221	14337	944	6905	211929	31578	2078	10674	327636	48819	3213
PV Sum (5%):	2450	33300	11190	732	5397	73345	24647	1613	8344	113389	38103	2494

Second-Order Impacts:

Tobacco Farming Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Tobacco	$/Lb	0.01	1.0
Domestic Tobacco Sales	Million Lbs	27	2.9
Export Tobacco Sales	Million Lbs	-12	-2.0
Total Tobacco Revenue	Million $	44	2.0
Quota Lease Revenue	Million $	22	6.5
Producers' Surplus	Million $	4	N.A.

Cigarette Industry Impacts:	**Units**	**Absolute Change**	**% Change**
Price of Cigarettes	$/1000	0.68	2.0
Domestic Cigarettes Sales	Millions	25618	4.4
Export Cigarettes Sales	Millions	-175	-0.3
Total Cigarette Revenue (Net of Federal Excise Tax)	Million $	1071	6.4

Tax & Consumer Impacts:	**Unit**	**Absolute Change**	**% Change**
Federal Excise Tax Revenue	Million $	205	4.4
Consumers' Surplus	Million $	1234	N.A.

Health Impacts:

Discount Rate	Change in Medical Costs (PV 1986 Million $)	Change in Expected Life (PV Years)
0 %	10386	-5049719
5 %	2501	-1159046

Employment Impacts by Sector (Change in Full-Time Equivalent Jobs):

Sector:	Tobacco	Cigarette	Warehouse	Support	Wholesale	Retail	TOTAL
Impact:	516	3112	17	400	1355	681	6080

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Study Group
Cigarette Safety
Act of 1984