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### State Anti-Smoking Legislation and the Demand for Cigarettes

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**State Anti-Smoking Legislation  
and  
The Demand for Cigarettes**

**Jean McIntire**

**March 1994**

## **I. Introduction**

This paper evaluates the effects of anti-smoking legislation on cigarette sales across the fifty states for the years 1975 through 1990. The relevance of this issue can be entertained from several perspectives as it pertains to both smokers and non-smokers contrasting the right to smoke with the right to breathe clean air. Anti-smoking legislation was initiated from early on in our country's legal history, not as a method of protecting non-smokers from the externalities imposed upon them by smokers with respect to their right to clean air, but rather in light of smoking's inherent fire hazards. The most significant development in the campaign of anti-smokers to promote the right to clean air came with the publishing of the 1964 Surgeon General's Report which reviewed more than 11,000 studies and concluded that cigarette smoking was causally related to lung cancer. The impact of this report which was released on January 11, led to 2% decline in total cigarette consumption for that year. It was not until the release of the 1986 Surgeon General's Report that the hazardous effects of cigarette smoke on non-smokers was affirmed. It asserted that not only did involuntary smoking cause disease in healthy non-smokers, but also that the mere separation of smokers from non-smokers within the same workspace was not sufficient to eliminate the risk to which they were exposed. These findings have ultimately led to a significant increase in the enactment of Clean Indoor Air Laws, and a growing intolerance of smokers everywhere.

This paper focuses on those characteristics in any given state which affect the level of cigarette sales, as well as the time trend in the growing anti-smoking sentiment. It also investigates the elements which contribute to the passage of such legislation. An analysis of the price elasticity of cigarettes in light of the effectiveness of anti-smoking legislation will lend valuable insight into the potential for generation of revenue through cigarette excise taxation, an issue which is of great interest to state governments as well as

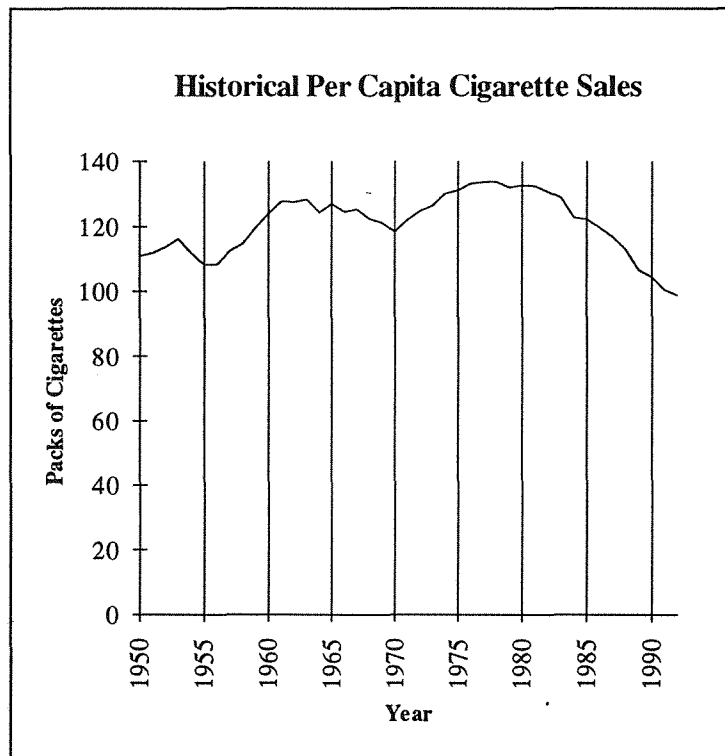
) the current administration as it attempts to direct revenue from sin taxes to fund health care reform.

## II. Theoretical Overview

### History of Regulation

It has been said that "...public regulation is a sort of political solution to an actual or anticipated conflict between various groups."<sup>1</sup> This can certainly apply to the tobacco industry and the American public. While the scope and extent of government regulation has fluctuated over the years, it has remained a consistent presence that has challenged the tobacco industry to defend itself against regulation that in some cases has led to an increase in the popularity of smoking.

Figure 1



Source: The Tobacco Institute

<sup>1</sup>Doron, Gideon (1979) p. 3

The controversy surrounding smoking has been directed both at the market practices of the tobacco industry, and later, as the health effects associated with smoking became apparent, at the externalities that cigarettes imposed on the general public. The tobacco industry has reacted vigorously to regulations that public opinion has imposed with various strategies that has ultimately left market penetration largely unaffected.

The cigarette industry historically has been characterized by anti-competitive behavior. The American Tobacco Company, formed in 1890 by consolidating five manufacturing companies, controlled ninety percent of cigarette production. By 1910 it had acquired monopolistic control over nearly every aspect of the industry and consequently had attracted the attention of the Department of Justice. In 1911, the Tobacco Trust, as it came to be known, was found to be in violation of the Sherman Act and divided into fourteen companies, four of which emerged with significant market potential. The American Tobacco Company, Liggett and Myers, P. Lorillard, and R.J. Reynolds were successful in obtaining a full ninety-two percent of the cigarette market by the early 1920's. The result of the dissolution led to incidence of collusive pricing practices, and the firms were found guilty of monopolization in both 1944 and 1946. The entry of Phillip Morris and Brown and Williamson in the 1930's resulted in the industry's current oligopolistic structure which allows these six firms a ninety-nine percent share of the cigarette market. The current market structure has led to a situation whereby firms engage in significant levels of advertising. The objective of this advertising is not one of market expansion, but rather to maintain or increase market share. The nature of this industrial structure has allowed the cigarette industry to position itself effectively against anti-smoking sentiment to the extent that reaction to various regulation has been well coordinated.

The intervention of the government in response to publications linking cigarette smoking to lung cancer and other diseases has proved to be surprisingly beneficial to the

industry. In 1951, a British study conducted by Dr. Richard Doll and Dr. A. B. Hill concluded that there was evidence of a causal link between smoking and various health risks. The report gained a considerable amount of media exposure, and had a significant impact on the American public. The 6.5% decrease in consumption that followed the first evidence of this correlation in 1951 may appear to be direct evidence of the concerns of smokers; however, this decline can also be attributed to a variety of other factors. The lower birth rate during the Depression reduced the size of the population. In addition, higher excise taxes, a drop in personal income, and the introduction of a rise in king-size cigarettes<sup>2</sup> reduced the impact of a health scare on the industry.

The response of the tobacco industry to these health scares led to clever product differentiation on the part of the tobacco industry with the introduction of a 'safer' cigarette, the filter brand. Cigarette filters reduce levels of tar, nicotine, and various trace elements found in tobacco smoke. Filters reduce the risks of lung cancer mainly due to the reduction in tar levels, a risk that is still four times greater than for that of a non-smoker. These products gained a 90 percent market share by 1976, a result which enabled "...the manufacturer to produce a cigarette with a smaller tobacco content while maintaining overall dimensions and avoiding waste of tobacco in the unsmoked fag-end."<sup>3</sup> Overall, this strategy resulted in a fifteen percent lower tobacco content in the average cigarette. Ironically, the industry actually benefited from this health scare by successfully introducing a product which led to a lower level of its most expensive input, thus incurring a net savings in production costs.

Further analysis of the health scares which prompted these responses lends valuable insight into the risks to which smokers rationally subject themselves, as well as the externalities that are imposed upon the non-smoking population. These externalities are the source of much of the recent restrictive anti-smoking legislation the states have

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<sup>2</sup>King size cigarettes contain 20 percent more tobacco than non-filter brands, thus altering the quantity of tobacco per unit ratio of cigarette consumption.

<sup>3</sup>Doron (1979) p. 13

passed. As of 1989, one out of every six American deaths was the result of cigarette smoking, an incidence which has prompted the Surgeon General to cite cigarette smoking as, "...the largest single preventable cause of premature death and disability in the United States, responsible for over 390,000 deaths annually."<sup>4</sup> The Doll and Hill study prompted President Kennedy, upon the advice of the Surgeon General, to approve the 1962 formation of the Advisory Committee on Smoking and Health. The 1964 release of the committee's report which came to be known as the Surgeon General's Report arrived at two primary conclusions: "Cigarette smoking is a health hazard of sufficient importance in the United States to warrant remedial action. Cigarette smoking is causally related to lung cancer in men; the magnitude of the effect of cigarette smoking far outweighs other factors. The data for women, although less extensive, points in the same direction."<sup>5</sup> These conclusions further suggested that cigarette smoking is associated with a seventy percent increase in the age-specific death rates of males. This evidence left little doubt as to the harmful effects to which smokers choose to subject themselves. As a result of the publicity devoted to these findings, per capita consumption declined in 1964 by almost five percent.<sup>6</sup>

Evidence mounted with respect to the hazards of smoking, but it was not until 1986 that the Surgeon General directly addressed the hazards of involuntary smoking, and the risks associated with exposure to second hand smoke. The three major conclusions of the report indicate that:

- 1) Involuntary smoking is a cause of disease, including lung cancer, in healthy non-smokers.
- 2) The children of parents who smoke compared with the children of non-smoking parents have an increased frequency of respiratory infections, increased

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<sup>4</sup>United States Department of Health and Human Services (1989)

<sup>5</sup>Doron (1979) p. 14

<sup>6</sup>Warner (1977)



respiratory symptoms, and slightly smaller rates of increase in lung function as the lung matures.

3) The simple separation of smokers and non-smokers within the same air space may reduce, but does not eliminate, the exposure of nonsmokers to environmental tobacco smoke.<sup>7</sup>

Evidence of the harmful effects of this exposure was available as early as 1972 when it was reported that "...sidestream smoke which comes from the lighted tip of the cigarette between puffs, has a higher concentration of some of the irritating and hazardous substances than does mainstream smoke (that inhaled by the smoker.)"<sup>8</sup> This report was integral in validating a non-smoker's right to breathe clean air in that it transformed what was once considered merely an annoyance into a credible and significant health risk.

The impact of these health risks on non-smokers resulted in the introduction of anti-smoking legislation, beginning in the 1970's.<sup>9</sup> While much of this legislation is enacted at the local level, smoking in public places has been regulated by increasing amounts of legislation at the state level. By 1990, 31 states and the District of Columbia had implemented some form of restriction against smoking in public places, and 19 states had enacted legislation that provided for some measure of restriction in the workplace. Since the mid 1970's the increase in both the rate and comprehensiveness of state legislation has contributed momentum to the anti-smoking movement. Local governments have significantly increased the adoption of these types of legislation since 1980, which lend weight to the impact of what is often less restrictive state legislation.

Smoking in the workplace is restricted through a combination of state and private initiatives. These restrictions not only reduce environmental exposure to tobacco smoke, they also alter smoking behavior and the public attitudes regarding tobacco use.

According to the 1986 Report of the Surgeon General, the workplace policies "...appear

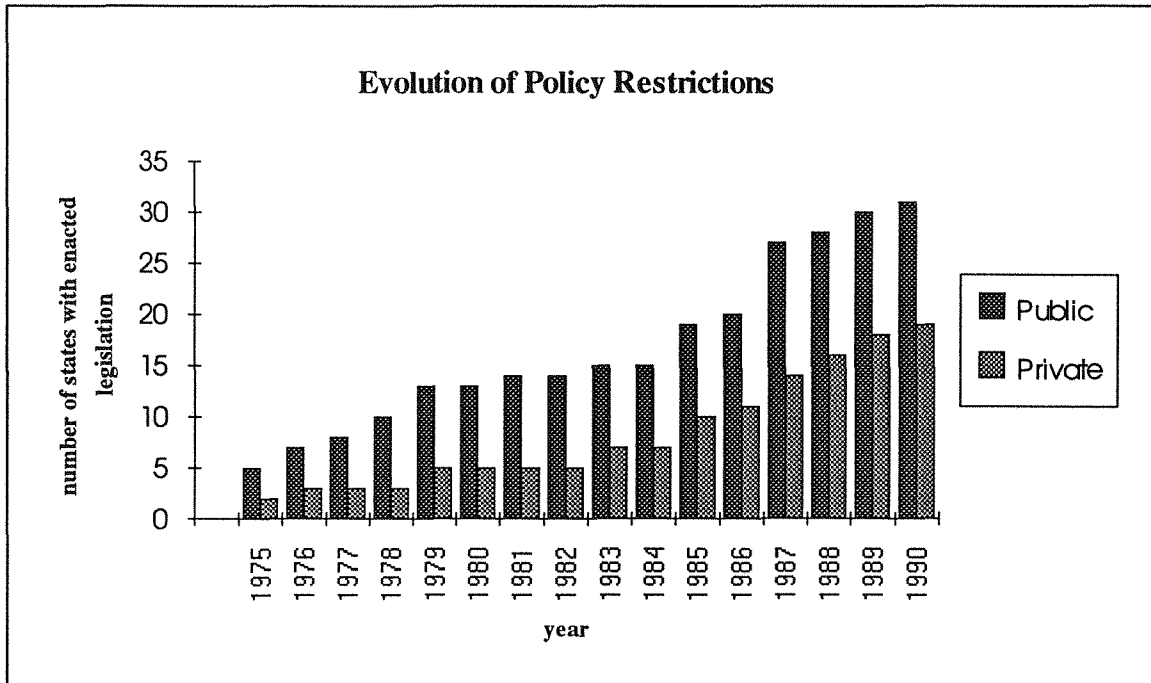
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<sup>7</sup>United States Department of Health and Human Services (1986)

<sup>8</sup>United States Department of Health and Human Services (1972)

to be followed by a decrease in smokers' cigarette consumption at work and an increase in enrollment in company-sponsored smoking cessation programs."<sup>9</sup>

Figure 2



Source: Coalition on Smoking or Health

Through a combination of regulatory incompetence, business savvy and luck, the tobacco industry historically has fared well in the face of regulation. This outcome is rooted in the manner in which the government reacted to medical research on smoking and health. Government response to the initial reports linking smoking and increased health risks prompted three major actions:

- 1) Passage of the 1966 labeling requirements which required health warnings on cigarette packaging and in all advertising. Later a warning was to appear on every cigarette advertisement.<sup>10</sup>
- 2) The Fairness Doctrine which essentially guaranteed free broadcast time for anti-smoking propaganda.

<sup>9</sup>United States Department of Health and Human Services (1986)

<sup>10</sup>Public Law 89-92 U.S.C. 1331-1339

- 3) The January 1977 prohibition of radio and television commercials for cigarettes.

Within one week of the release of the 1964 Report of the Surgeon General, the Federal Trade Commission (FTC) initiated trade regulations regarding deceptive advertising and labeling which resulted in the ruling requiring all cigarette and advertising and packages to display the notice, "Cigarette smoking is dangerous to health and may cause death from cancer and other diseases."<sup>11</sup> A significant lobbying effort on the part of the tobacco industry led to the Congressional enactment of the Cigarette Labeling and Advertising Act which reduced the severity of the warning to "Cigarette smoking may be hazardous to your health."<sup>12</sup> Empirical evidence (Warner 1977) suggests that in the absence of the 1964 Surgeon General's Report, per capita consumption would have increased rather than decline at a rate of five percent that year. Omitting both the report and the wake of regulation that ensued would have resulted in a steady rate of consumption from 1964 to 1972, rather than the ten percent decline experienced during the period. From a regulatory perspective, the impact of this and other health scares may be even more significant in light of research conducted by Andrew Jones (1989) which indicates that this type of information affects those contemplating participation in the act of smoking rather than the level consumed by existing smokers.

The Cigarette Labeling and Advertising Act led directly to the 1967 regulation by the Federal Communications Commission (FCC) known as the Fairness Doctrine which required broadcasters to allocate free broadcast time to health groups to promote anti-smoking messages. The measure of balance required that the ratio of cigarette commercials to anti-smoking commercials be set at three to one. This regulation had the desired effect of reducing cigarette sales. Inspired by this victory, the FCC attempted to ban the advertising of cigarettes altogether, an effort that culminated in the Public Health

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<sup>11</sup>Doron (1979) p. 15

<sup>12</sup>ibid. p. 15

Cigarette Smoking Act of 1969 which was suspended until July of 1971 in exchange for voluntary compliance. By its nature, this effectively repealed the Fairness Doctrine, a regulation which was having a significant impact on cigarette sales. The number of anti-smoking spots diminished, which led to a significant increase in the consumption of cigarettes. Hamilton (1971) concluded that the anti-smoking messages associated with the Fairness Doctrine reduced per capita consumption by 530.7 cigarettes per year, while advertising increased it by only 95.0 cigarettes per year. The savings imposed on the industry in the form of reduced advertising expenditure combined with the surge in consumption associated with the repeal of anti-smoking propaganda resulted in an overall stimulus to the industry. In an ironic twist, it has become evident that the firms were aware of these effects before the enactment of the regulation.

These regulations have set the stage for recent legislative developments in the government's attempt to mitigate exposure to the harmful effects of cigarette smoke. The prospect for increased legislation designed to restrict smoking is promising. The majority of legislation is enacted at the state level, and represents a significant policy shift during the past decade. Between 1970 and 1974, nine laws were adopted in eight states. During the next four year period, fifteen states were responsible for the passage of twenty-nine new laws. The most logical explanation of this trend in restrictive policy is a shift in public attitudes. Although it was not the first state to impose anti-smoking legislation, the passage of the Minnesota Clean Air Act of 1975 was the seminal legislative action. This landmark ruling covered restaurants, private workplaces, and a number of public places in an attempt to "...protect the public health, comfort, and environment by prohibiting smoking in public places and at public meetings except in designated smoking areas."<sup>13</sup> This comprehensive law became the model for other states, and within five years, three additional states adopted this type of restriction. By 1986, a full eighty percent of the United States population resided in states that had adopted some form of legislation with

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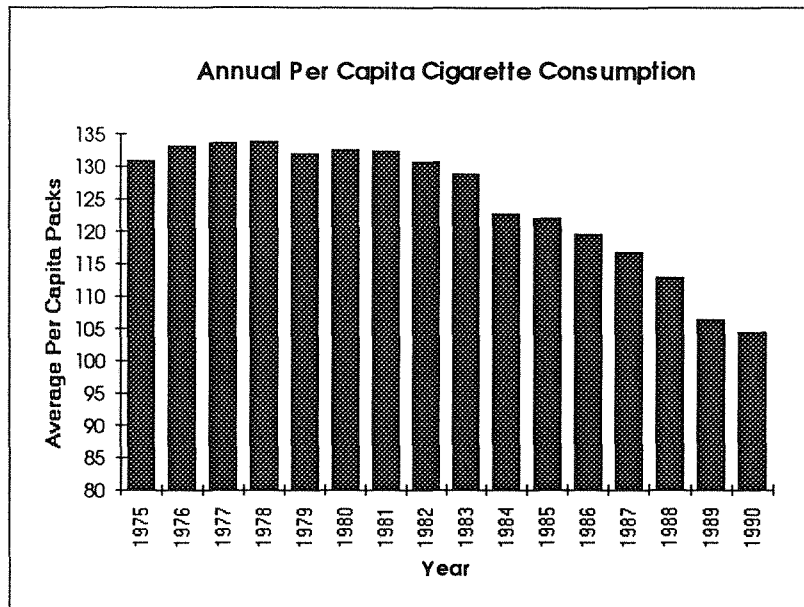
<sup>13</sup>United States Department of Health and Human Services (1986)

the intent of protecting nonsmokers from the externalities imposed by cigarette smoke. States without this legislation are concentrated in the Southeast including Kentucky, North Carolina, Mississippi, Alabama, and Georgia. The prominence of the tobacco industry in this region lends some insight to this occurrence. Enactment of these types of legislation indicate the growing concern regarding the harmful effects of cigarette smoke, as well as an increase in anti-smoking sentiment. "It isn't about whether smoking is an annoyance anymore. The debate is over how to protect the public from an acknowledged health risk while protecting the rights of smokers to use a legal product." (Sylvester p.36)

The complexity of this issue has implications for every member of society. The tobacco industry continues to exert a considerable amount of political influence. In every case of proposed state legislation restricting the rights of smokers, the tobacco industry has demonstrated its willingness to employ any methods available to discourage its passage. Political and financial maneuvering, as well as media campaigns have been successful strategies in the attempt to avoid the enactment of further legislation. The industry has also been successful in gaining support from some of the businesses that would be hurt in the event restrictive legislation is enacted. A tactic of shifting the debate to reflect the infringement of personal freedom this type of legislation imposes on smokers has also gained the support of civil liberty organizations and labor unions, but the trend seems to reflect diminishing returns to these activities. The rights of both smokers and nonsmokers are viable, but the democratic process has asserted the prevalent issue to be the public's right to breathe clean air.

The historical evidence implies that smokers are well informed about the health risks to which they subject themselves. Declines in consumption associated with health scares and the publicity that accompanies them demonstrate that this information has had some impact on the long run attitudes of smokers. However, the tobacco industry continues to thrive as smokers choose to smoke despite the ominous warnings of medical research.

Figure 3



Source: The Tobacco Institute

Recent empirical evidence suggests the greatest effect of these warnings concerns the decision to smoke rather than the consumption rate of the individual smoker. The addictive nature of this behavior is an important component in the analysis of this result. The attitudes of non-smokers have also been affected by these findings by nature of the externalities that are imposed upon them. What was once a nuisance has become a health concern, and policy has responded. This paper will address the magnitude of the impact that anti-smoking legislation has had on the behavior of smokers.

### Previous Empirical Studies

A considerable body of empirical evidence deals with the demand for cigarettes. Kenneth Warner has made significant contributions to the subject. In a 1977 study, "The Effects of the Anti-Smoking Campaign of Cigarette Consumption," he concluded that the effects of health scares were transitory, while the cumulative effect of years of anti-

smoking publicity had a substantial impact on smoker behavior. He is also credited with having contributed to the study of the effects of smuggling. The extent of this activity cannot be accurately reported due to its covert nature, but in a 1982 article entitled "Cigarette Excise Taxation and Interstate Smuggling: An Assessment of Recent Activity," Warner reports estimates of between \$400-\$500 million per year in the mid 1970s. He quotes statistics that indicate "...a single truckload of cigarettes can generate smuggling profits of \$12,000 to \$20,000."<sup>14</sup> This caused major revenue disruptions for some higher price states some of whom lost as much as one-sixth of tax collections to smuggling. Another problem associated with this phenomenon lies in the fact that states have chosen not to raise excise taxes based on their fear of inciting additional smuggling, an activity initiated largely by organized crime, as raising taxes increases the incentive to smuggle. This led to a decline in real cigarette prices during periods of high inflation. Through 1981, federal excise tax remained constant at its 1952 level of 8 cents per pack. This contributed to the decline in real cigarette price as stated. It is a federal excise tax which, due to its constant influence across the states, remains the only viable source for additional cigarette tax revenue. The enactment of the Federal Cigarette Contraband Act of 1978 and its enforcement by the Bureau of Alcohol Tobacco and Firearms led to a recovery of \$82 million by the states in fiscal 1980. While the study does not rule out the fact that the legislation may have made a significant contribution to the recovery of that revenue, it is also important to note that the real dollar gap between the high and low price states closed during this same period, thus reducing the incentive to smuggle. In addition, transportation costs rose considerably during this time increasing the expense of engaging in this activity.

Warner's 1981 contribution to the literature, "State Legislation on Smoking and Health : A Comparison of Two Policies," lends considerable insight into the effects of tax increases in response to anti-smoking sentiment as well as the increase in the level of state

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<sup>14</sup>Warner (1982)

anti-smoking legislation associated with this growing campaign. Warner makes the case that the growth in excise taxation diminished with the recognition that interstate bootlegging was becoming a major concern. The demand for cigarettes is relatively inelastic, but taxation has had some impact on reducing consumption. He reports that the cigarette industry is considered to be a constant cost industry implying that real changes in the price of cigarettes are attributed largely to changes in taxes.

With respect to anti-smoking legislation, Warner concludes that these laws are reflecting changes in smoking behavior rather than contributing to them. He posits the expectation that, while this legislation is not intended to reduce the amount of smoking, given the level of restrictiveness in some states, this is an inevitable outcome. He notes the high correlation between increased legislation and a decline in consumption and attributes it to a behavioral response to the cumulative effects of the anti-smoking campaign when taking into account the lag in knowledge accumulation regarding health scares as well as attitudinal changes. He acknowledged in his findings the significant lack of empirical evidence to substantiate his claim, but cited legislation as merely a reflection of social values.

The issue of the impact of health scares which Warner addressed was entertained in a 1981 study, "Governmental Regulation of Cigarette Health Information," conducted by Schneider, Klein and Murphy. This research estimates demand for per capita consumption of cigarettes from 1930 to 1978. After an initial upward trend, consumption was found to have peaked in 1963, and then gradually declined. This trend is examined by estimating an equation in which consumption is specified as a function of real per capita income, real retail price, advertising stock, and dummy variables for the period of the regulation imposed by the Fairness Doctrine, as well as for the 1953 and 1964 health scares. These health scares included the first report of the American Cancer Society correlating smoking and death rates, and the 1964 Surgeon General's Report. Both of these events are believed to have permanently lowered the rate of cigarette consumption.



Results of this study indicate that previous empirical evidence had underestimated the effects of health scares on cigarette demand. Insight is shed as to the importance of examining the amount of tobacco consumed during the period rather than the number of cigarettes. The study also concludes that the broadcast ban on advertising had the effect of increasing consumption, the mechanism of which is discussed above. This study also deals with the impact of health information on smokers. Their findings conclude that by 1978, per capita tobacco consumption was almost fifty percent lower than it would have been in the absence of health scares. This provides valuable insight into the arguments that enter into the utility function of a smoker in that they are well informed of the inherent dangers of smoking and continue to consume cigarettes despite the risks.

The effect of health scares on smokers was approached from a much different perspective by Gary Becker and Kevin Murphy in their 1988 approach to the topic entitled, "A Theory of Rational Addiction." They concluded that addiction to a substance such as nicotine was rational with respect to the choices of a rational forward-looking utility maximizer with stable preferences. A rational person recognizes that consumption of a harmful substance such as cigarettes has a negative effect on future utility, while consumption of a beneficial good has positive effects on future utility. A person is addicted to a good only if past consumption of that good raises the marginal utility of present consumption. In that addictions involve an interaction between people and goods, present-oriented individuals are potentially more addicted to harmful goods than future-oriented individuals, as they discount the future at a higher rate.

The contribution to the literature made in 1989 by Andrew Jones, "The UK Demand for Cigarettes 1954-1986, A Double-Hurdle Approach," was useful in calling to light the separate components in the choices made by smokers. The initial decision to smoke is made independently of any physical or psychological addiction to cigarettes. He concluded that health scares have affected the participation component of smoking more significantly, and have left consumption among continuing smokers relatively constant.

He refers to a limit in the duration of consumption effects among existing smokers in the wake of a health scare. The effects of such shocks primarily affect the incidence of starting and quitting and have relatively little impact on the quantity of cigarette consumption. He cites evidence suggesting that the impact on participation rates with respect to income effects is most significant among financially constrained teenagers. These results imply that while the impact of health scares trails off in the short run, these events are cumulative in nature and have the effect of influencing social behaviors which over the long run may have a significant and permanent effect on consumption.

The issue of smuggling in response to state cigarette taxation was addressed in the 1985 Advisory Commission of Intergovernmental Relations (ACIR) study entitled, "Cigarette Bootlegging: A State and Federal Responsibility." This study consisted of a pooled time series of state cross-sections from 1981 to 1983. Findings suggest smuggling to be a statistically significant variable in the specification of the demand for cigarettes. Tax evasion resulting from the transportation of cigarettes from those states with lower tax rates for sale in states with higher taxes was cited by the Federation of Tax Administrators as, "...the most troublesome in the entire State tax field."<sup>15</sup> Given the low weight to unit ratio and the leniency of smuggling penalties, the potential profitability of such an endeavor has attracted a range of participants from informal smugglers to organized crime. The study analyzed the impact of several influences on cigarette sales including price, per capita income, an index of tourism which captures the informal component to bootlegging, percent of population of the legal smoking age, dichotomous variables which capture the long distance component to organized smuggling, and an index of the border state price differential which captures interstate smuggling incentives. This study also includes an index of religious preference which varies according to state and has a significant impact on demand. Some variables that were omitted for simplicity as preceded by previous studies include urban-rural and male-female ratios. In this

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<sup>15</sup>Advisory Commission of Intergovernmental Relations (1977) p.1

study, the inclusion of regional dummy variables was extremely important. Omitting them from the regression resulted in a decline in every variable's coefficient, and relegated the variables for religion, price differential and income to statistically insignificant levels.

Interstate smuggling also proved to have a significant impact on the results.

This subject was expanded upon in a 1986 study conducted by Badi Baltagi and Dan Levin entitled, "Estimating Dynamic Demand for Cigarettes Using Panel Data: The Effects of Bootlegging, Taxation, and Advertising Reconsidered." This study pooled the data of forty-six states over the period from 1963 to 1980. Using pooled estimation techniques, a price elasticity of -0.2 was obtained. Income elasticity was determined to be insignificant. The model specified per capita consumption of cigarette sales as a function of real price, the price of cigarettes in any neighboring state, real disposable income per capita, a per capita index of advertising, and health dummy variables to capture the effects of the various health scares that have come about due to the findings of medical research. The significance of smuggling across state lines is included in the model, but no attempt is made to address the incidence of long distance organized smuggling. The study focused on two major regulatory events which were believed to have changed the effect of advertising on consumption of cigarettes. These include the Fairness Doctrine and the 1969 broadcast ban on cigarette advertising. Ordinary Least Squares (OLS) estimates of the coefficients for these variables are insignificant. Due to the fact that there is no variance across states with respect to the impact of these regulations, sophisticated econometric techniques were employed to distinguish between the effects in consumption attributed to advertising, and those that are due to the habit of consumption. This study sheds some interesting light on the validity of conducting static studies on the determinants of cigarette demand. The results produced lower price elasticity than previously conducted specifications of a similar nature (Hamilton 1972), (Lyon and Simon 1968). In contrast with these types of studies, Bagtali and Levin found insignificant income elasticity and small but significant

smuggling effects. The impact of advertising in light of the two major regulatory events was determined to be insignificant.

Hamilton also entertained the impact of advertising on cigarette consumption in his 1972 study, "The Demand for Cigarettes: Advertising, the Health Scare, and the Cigarette Advertising Ban." He concluded that health scares had more of an impact on the decline in cigarette smoking than the positive effects of advertising during the period. This contributes important insight into the signaling mechanism implicit in restrictive smoking policy. Given that these warnings have an important long run effect on consumption patterns, his findings imply that the effects of legislation which reinforce the significant hazards associated with smoking may make a significant contribution to a decline in consumption.

The issue of legislation was rigorously treated in the 1988 study, "Clean Indoor Air and Demand for Cigarettes," by Frank Chaloupka and Henry Saffer. This study addressed the impact of anti-smoking policy on the demand for cigarettes. It was conducted across the fifty states from 1975 to 1985, and specified the demand for cigarettes as a function of price, income, policies regarding anti-smoking legislation in both public places and in the workplace, incentives for smuggling across state lines, and stress variables that proxy the tastes and preferences of cigarette smokers. Both single equation and simultaneous models were estimated to produce results which indicate the significance of restrictions in public places, but insignificant effects of private workplace restrictions.

Chaloupka extended this theory in his 1991 article, "Rational Addictive Behavior and Cigarette Smoking", into an empirical analysis of the demand for cigarettes to discover that smoking is in fact an addictive behavior and that smokers do not behave myopically. The younger and less educated are among those who are less concerned with the future, and thus more inclined to be addicted to these types of substances. He concluded that long run price elasticities indicate that those individuals who are more

heavily addicted to cigarette smoking will be more responsive to changes in price in the long run than those less addicted individuals.

Wasserman, Manning, Newhouse, and Winkler conducted a 1991 study called "The Effects of Excise Taxes and Regulations on Cigarette Smoking" in which they determined cigarette price elasticity to be unstable between 1970 and 1989. Using an extensive specification of the interaction of price, income, regulation, education and birth cohort, they found evidence of significant shifting in the parameters. Their findings report that regulations restricting smoking in public places have a significant negative impact on cigarette demand. They conclude that these regulations convey a message to the smoker that their behavior is unacceptable, which may supersede the more obvious element of deterrence that the policy implies.

Stoddart, Labelle, et. al., in their study entitled, "Tobacco Taxes and Health Care Costs," shed interesting light on the social costs imposed by smokers with respect to their contribution to rising health care costs. A common impression exists among non-smokers that health care costs incurred by smokers outweigh revenues collected through cigarette excise taxes in the funding of the Canadian health care system. This is of interest in light of this administration's choice to impose excise taxes to fund a national health care plan. In addition to these health care costs there remains the allegation that productivity declines in the wake of smoking-related illness. The authors concluded that "...smokers do not impose a net financial externality on non-smokers through their health care utilization."<sup>16</sup> Their results concluded that health care expenditure estimates amounted to less than one-third of collected excise tax revenues, a result which conflicts directly with conventional wisdom. This implies that policies intended to restrict consumption based upon reducing health care expenditures are misdirected.

The results of this body of research indicate consistent evidence of a negative correlation between anti-smoking legislation and cigarette consumption. There is

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<sup>16</sup>Stoddart (1986) p. 65

however, some question as to the causation of this observed decline. The law may either precipitate the behavior or reflect pervasive social attitudes regarding smoking. Health scares and the knowledge their publicity conveys to smokers have been proven to have a significant impact on cigarette consumption; however, individuals continue to smoke despite the apparent risks. While this behavior may be explained by the addictive nature of cigarette consumption, a function of the rate of time preference at which future utility is discounted, the long term effects of this information cannot be ignored. The net effect of the cumulative aspects of health consequences appears to impact the decision to smoke more heavily than actual consumption rates. The lag in declines in consumption that accompanies this information implies that the effect of anti-smoking legislation may be one of information rather than regulation. As a barometer of social opinion, public policy conveys the message to smokers that their behavior and the externality it imposes on society is unhealthy, and thus unacceptable. This change in attitude that the policy reinforces is suggested to be the definitive cause of falling levels of consumption, rendering them an effective tool in the reduction of cigarette demand.

### III. The Model

#### Specification

This model is derived from microeconomic theory which consists of an individual who maximizes utility subject to a budget constraint. One of the arguments in this utility function is cigarettes. Constrained optimization yields a demand function for cigarettes as a function of price, the prices of other goods, income, and tastes and preferences.

$$D = f(\text{PRI}, \text{INC}, \text{POL}, \text{PH}, \text{PL}, \text{DIV}, \text{ED}, \text{REL})$$

where: PRI = the price of cigarettes

INC = income

POL = anti-smoking legislation

PH = price of other goods

PL = price of bootleg cigarettes

DIV = divorce rate as a proxy for stress

ED = educational attainment rate

REL = religious affiliation

The economic theory that underlies this model predicts that the price of cigarettes will have a negative effect on the demand for cigarettes. Anti-smoking restrictions impose non-pecuniary costs on smokers and will be included in the specification to include this component of cost. Restrictive legislation with respect to smoking in both public and private places will be added to the demand specification. Given that these types of legislation were initiated with the 1975 Minnesota Clean Indoor Act, and that there is a lag in passage of such legislation with respect to both education of the constituency as well as considerable lobbying by the tobacco industry, the length of the study will extend through

to 1990 to incorporate the growing trend in anti-smoking sentiment. The complete specification of the single equation demand function is modeled as:

$$C_1 = \beta_0 + \beta_1(\text{price}) + \beta_2(\text{income}) + \beta_3(\text{public law}) + \beta_4(\text{private law}) + \beta_5(\text{high price}) + \beta_6(\text{low price}) + \beta_7 D_1 + \beta_8 D_2 + \beta_9 D_3 + \beta_{10}(\text{divorce}) + \beta_{11}(\text{religion}) + \beta_{12}(\text{education}) + \mu_1$$

Price is the state tax paid per capita cigarette sales. It is expected to be negatively correlated with sales with an elasticity less than one. Income is expected to have a positive coefficient, with an elasticity less than one, indicative of the fact that cigarettes are not considered to be a luxury good. Public Law is a variable equal to one if state has a law restricting cigarette smoking in at least four public places including restaurants and zero otherwise. It is designed to model the effects that the increase in anti-smoking legislation has had on cigarette sales. The Private Law variable is structured in the same manner, and models the effects that further restriction which extends into the workplace has had on consumption. The coefficients for both variables are expected to be negative, but previous empirical evidence, (Chaloupka and Saffer 1988) suggests that while public restrictions impact the level of consumption, the private law variable may be statistically insignificant. Both variables are expected to be negatively correlated with sales.

The effects of bootlegging will be modeled using an approximation of the incentive for interstate smuggling which was used in a 1977 study conducted by the Advisory Commission of Intergovernmental Relations (ACIR). A variable for high price captures the effects of interstate border smuggling by modeling the increase in demand for a given state that results from an increase in the purchase of cigarettes within that state by consumers from the higher price states with which it borders. Given the increase in apparent demand within that state, the variable is expected to be positively correlated with sales. A variable for low price captures the incentive for a given state to purchase



bootleg cigarettes from the lower price states with which it borders. These cigarettes are substitutes for the cigarettes sold in that state. That state will exhibit a reduction in apparent demand, thus the low price variable is expected to be positively correlated with sales.

The index for higher price states = PH

$$PH = \frac{\sum_{j=1}^K (P_j - P) (\text{population of border state})}{\text{population of base state}}$$

where:

K = number of higher price bordering states

$P_j$  = price in  $j^{\text{th}}$  higher price bordering state

P = price in base state

The index for lower price states = PL

$$PL = \frac{\sum_{i=1}^n (P - P_i) (\text{population of base state})}{\text{population of base state}}$$

n = number of lower price bordering states

P = price in base state

$P_i$  = price in the  $i^{\text{th}}$  lower price bordering state

A variable which models the incentive to engage in long distance smuggling will also be incorporated through the use of regional dummy variables. The dummy variables capture the incentive to engage in long distance smuggling in a more organized manner from regions of the country with disproportionately lower prices due to lower tax rates.

The long distance dummy variable are modeled as:

$D_1 = 1$  in West, 0 in East

$D_2 = 1$  in lowest price in Northeast, 0 otherwise

$D_3 = 1$  in lowest price in South, 0 otherwise

Table 1 illustrates the tax rate structure which contributes to the incentive to engage in this type of activity in that state excise taxes account for the greatest source of variability in state prices.

**Table 1**

**1990 State Tax Rates (cents per pack)**

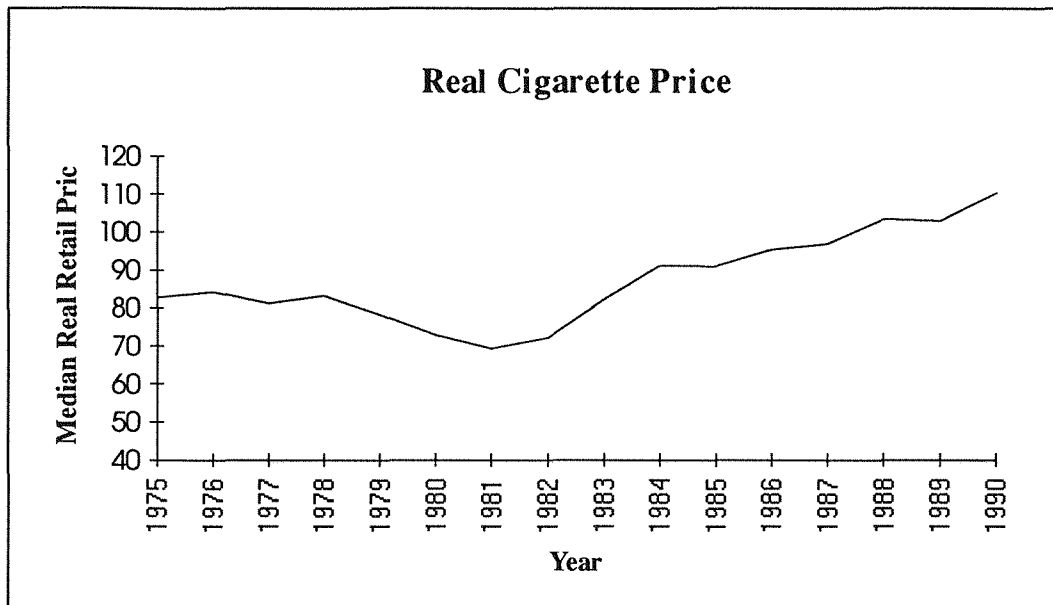
<b>New England</b>		West Virginia	17
Maine	31	North Carolina	2
New Hampshire *	25	South Carolina	7
Vermont	17	Georgia	12
Massachusetts	26	Florida	33.9
Rhode Island	37	<b>East South Central</b>	
Connecticut	40	Kentucky	3
<b>Middle Atlantic</b>		Tennessee	13
New York	39	Alabama	16.5
New Jersey	40	Mississippi	18
<b>East North Central</b>		<b>West South Central</b>	
Pennsylvania	18	Arkansas	21
Ohio	18	Louisiana	20
Indiana	15.5	Oklahoma	23
Illinois	25	Texas	26
Michigan	25	<b>Mountain</b>	
Wisconsin	30	Montana	18
<b>West North Central</b>		Idaho	18
Minnesota	38	Wyoming	12
Iowa	31	Colorado	20
Missouri	13	New Mexico	15
North Dakota	30	Arizona	18
South Dakota	23	Utah	23
Nebraska	27	Nevada	35
Kansas	24	<b>Pacific</b>	
<b>South Atlantic</b>		Washington	34
Delaware	24	Oregon	28
Maryland	13	California	35
District of Columbia	17	Alaska	29
Virginia	2.5	Hawaii	42

Source: The Tobacco Institute

\* Although New Hampshire appears to be a higher price state, it was the lowest price state in the Northeast for much of period studied. See Appendix 1

Smuggling became an increasing problem throughout the period being studied as the real price of cigarettes was rising, thus increasing the incentives for this type of activity.

Figure 4



Source: The Tobacco Institute

Tastes and preferences which characterize each state will be modeled by divorce as a proxy for stress, as well as the degree of the state population's affiliation with those religions which discourage smoking. Divorce is expected to be positively correlated with cigarette sales. Religion is expected to be negatively correlated with sales as both Southern Baptists and Mormons, the populations which define the variable, prohibit believers from smoking.<sup>17</sup> Given the body of empirical evidence suggesting a correlation between education and health, an educational attainment variable will also be included in the specification and is expected to be positively signed.

<sup>17</sup>Extensive analysis of the effect of various religious affiliations on cigarette smoking was conducted in the ACIR (1977) specification of cigarette demand. This combination was determined to most accurately represent the effect of religion on cigarette consumption.

The results of the single equation model ignore the endogeneity of price, and both policy variables. A simultaneous equations model will be used to take into account the interaction between supply and demand.

The demand curve has been modified and is specified as:

$$Q^D = \alpha_0 + \alpha_1(\text{price}) + \alpha_2(\text{income}) + \alpha_3(\text{public law}) + \alpha_4(\text{private law}) + \alpha_5(\text{smuggling index}) + \alpha_6(\text{divorce}) + \alpha_7(\text{education}) + \alpha_8(\text{religion}) + \epsilon_1$$

In some of the specifications of this model, the smuggling index was reduced to represent the net effect of the incentive to smuggle cigarettes from a state, and is defined as PH-PL.

The supply curve for cigarette sales can be specified as a function of real cigarette price and costs to the firm. Microeconomic theory predicts a positive correlation between cigarette price and quantity supplied. Transportation costs are represented by the distance between Norfolk, Virginia, the site from which over 95 percent of all cigarettes are shipped, and either the state capital or the state's largest city. This variable is expected to be negatively correlated with the amount of cigarette sales supplied. Real tobacco price is modeled as influencing the production of cigarettes as an input. It is also expected to be negatively correlated with sales. The supply function is written as:

$$Q^S = \beta_0 + \beta_1(\text{price}) + \beta_2(\text{distance}) + \beta_3(\text{tobacco price}) + \epsilon_2$$

The policy variables have been collapsed for simplicity into a single variable which represents the existence of either type of legislation in a state for a given year. This linear probability model is specified as a function of state characteristics which determine its passage. The error terms in this model are not normally distributed, but the Central Limit Theorem applies, and 816 observations effectively minimizes this effect. The fact that the errors are heteroskedastic does not bias the estimators, but does effect their efficiency.

The amount of sales within a state represents the apparent level of smoking within that state. Sales are expected to be negatively correlated with the legislation of anti-smoking policy. Income and educational attainment are included in the specification to model the individual characteristic of smokers. Both are expected to be positive. Probit estimation of the effects of religious affiliation indicated no significant correlation between religion and policy implementation. Voter participation was included as a representation of the state's political awareness. It is expected to be positively correlated with the probability of passage. The equation is specified as:

$$P = \delta_0 + \delta_1(\text{sales}) + \delta_2(\text{income}) + \delta_3(\text{education}) + \delta_4(\text{voter participation}) + \epsilon_3$$

The equilibrium condition states that supply must be equal to demand and is an identity that completes the simultaneous equations model :

$$Q^D = \alpha_0 + \alpha_1(\text{price}) + \alpha_2(\text{income}) + \alpha_3(\text{public law}) + \alpha_4(\text{private law}) + \alpha_5(\text{smuggling index}) + \alpha_6(\text{divorce}) + \alpha_7(\text{education}) + \alpha_8(\text{religion}) + \epsilon_1$$

$$Q^S = \beta_0 + \beta_1(\text{price}) + \beta_2(\text{distance}) + \beta_3(\text{tobacco price}) + \epsilon_2$$

$$P = \delta_0 + \delta_1(\text{sales}) + \delta_2(\text{income}) + \delta_3(\text{education}) + \delta_4(\text{voter participation}) + \epsilon_3$$

$$Q^S = Q^D$$

## Data Sources

Cigarette Sales	State tax-paid cigarette sales in packs per capita. Data taken from "The Tax Burden on Tobacco." $\mu = 124.75$ $\sigma = 30.27$
Real Cigarette Price	Average state retail price per pack in cents deflated by the Consumer Price Index (1982-1984 = 100). Data taken from the 1992 edition of "The Tax Burden on Tobacco." $\mu = 87.11$ $\sigma = 14.15$
Public Place Law	Dichotomous variable equal to 1 if restriction applies to at least four public places, including restaurants, 0 else. Taken from "State Legislated Actions on Tobacco Issues." $\mu = 0.33$ $\sigma = 0.47$
Private Place Law	Dichotomous variable equal to 1 if state has enacted a law restricting cigarette smoking in private workplaces. Taken from "State Legislated Actions on Tobacco Issues." $\mu = 0.16$ $\sigma = 0.37$
Real Income	Per capita disposable personal income divided by the Consumer Price Index (1982-1984=100). $\mu = 10246.31$ $\sigma = 1696.94$
Smuggling Index	Price differential weighted by relative state population taken from Census Data 1970-1990. $\mu = 21.13$ $\sigma = 75.99$
Religion	Fraction of total state population that are either Mormons or Southern Baptists obtained from "Churches and Church Membership", a publication of the Glenmary Research Institute. $\mu = 10.91$ $\sigma = 2.31$
Divorce	Percentage rate of divorce per 1000 of the total population residing in state. Taken from the Statistical Abstract. $\mu = 5.31$ $\sigma = 1.95$
Education	Percentage of state population age 25 and over who had completed four years of high school. Taken from the Digest of Educational Statistics. $\mu = 70.21$ $\sigma = 8.66$
Distance	Distance from Norfolk, Virginia to either state capital or state's largest city. Taken from the Rand McNally Road Atlas. $\mu = 1230.8$ $\sigma = 980.5$

Tobacco Price

Average price paid to farmers divided by Tobacco Price Index. Taken from U.S.D.A. Agricultural Statistics.  
 $\mu = 1.41$   $\sigma = .219$

Voter Participation

Percentage of the population that voted in election for State Representative, averaged for non-election year. Taken from the Statistical Abstract.  $\mu = 1.41$   $\sigma = 0.219$

## IV. Analysis

### Single Equation Analysis

Initial regression results of the single equation demand function were estimated with OLS and analyzed to detect the presence of heteroskedasticity. A regression of the absolute values of the residuals on the fitted values of the dependent variable resulted in a t-statistic of 8.377. Log linear specification results produced a t-statistic of 1.57 which rejects the null hypothesis that the absolute values of the error terms are correlated with the fitted values for sales. This transformation is variance stabilizing.

Although the OLS method of estimation has been employed in similar empirical work, it ignores both the panel structure of the data and the endogeneity of both price and the policy variable. Panel estimation of a fixed effect or Within model assumes that there are common slopes but that each cross-sectional unit has its own intercept.<sup>18</sup> Between estimation assumes that both the slopes and intercepts vary across the individual means of the cross-sectional units, but is less efficient than a random effects model in that it loses a significant number of degrees of freedom in its estimation. A random effects model is estimated whenever a Hausman test of the ratio of fixed versus random effects rejects the null hypothesis of zero correlation between the error term and the explanatory variables. This method is the most efficient method of estimation as it does not sacrifice degrees of freedom which are necessary to compute individual intercept terms. A random effects model assumes common slopes but that the intercepts for each state are random and drawn from a common distribution. An F-statistic is reported for each estimation which tests the hypothesis that all intercepts are equal. P-values of zero were obtained for each

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<sup>18</sup>This type of model proved to be inestimable in some specifications due to near perfect multicollinearity between the dichotomous policy variables and some of the state specific variables.



estimated specification and indicate random effects estimation. Results of these estimates are reported in Table 2.

**Table 2**  
**Single Equation Model**  
Panel Estimates (Random Effects Model)

Variable	Equation 1	Equation 2	Equation 3	Equation 4	Equation 5	Equation 6
Constant	6.33 (16.4)*	6.31 (16.19)	6.28 (16.38)	6.17 (15.96)	5.75 (14.97)	5.62 (14.97)
Price	-.628** (-20.37)	-.643 (-18.99)	-.644 (-19.15)	-.630 (-17.84)	-.595 (-17.13)	-.571 (-16.4)
Income	.144 (2.79)	.149 (2.91)	.153 (3.04)	.151 (3.02)	.357 (6.25)	.353 (6.31)
Public Law	-.088 (-6.94)	-.089 (-6.70)	-.085 (-6.71)	-.086 (-6.75)	-.079 (-6.36)	-.082 (-6.63)
Private Law	.017 (1.06)	.016 (1.03)	.013 (.846)	.013 (.867)	.0092 (.608)	.015 (.993)
High Price Smuggling Incentive		.00037 (.095)	-.00021 (-.055)	.00011 (.029)	.00341 (.899)	.0053 (1.41)
Low Price Smuggling Incentive		.00495 (.898)	.0049 (.886)	.00389 (.707)	.0105 (1.93)	.011 (2.06)
Dummy for West			-.0939 (-2.24)	-.107 (-2.64)	-.063 (-1.53)	-.034 (-.925)
Dummy for lowest price in Northeast			.548 (3.86)	.542 (4.08)	.574 (4.31)	.506 (4.26)
Dummy for lowest price in South			.120 (2.13)	.181 (2.28)	.167 (2.10)	.259 (3.51)
Divorce				.047 (1.40)	.079 (2.35)	.124 (3.66)
Education					-.405 (-7.03)	-.402 (-7.05)
Religion						-.041 (-4.05)
R <sup>2</sup>	.539	.505	.514	.512	.572	.580

\*t statistics appear in parenthesis

\*\*coefficients for explanatory variables appear as elasticities

Equation 1 specifies demand in its simplest form to analyze the effects of both types of policy. Price elasticity of -0.628 , while higher than expected, is still within the

inelastic range established by previous empirical work.<sup>19</sup> Income elasticity of 0.14 indicates that cigarettes are considered to be a necessity, a view consistent with the addictive nature of cigarette consumption. Public policy exhibits a strong effect on demand indicating a 0.08% decrease in cigarette sales for those states with public laws enacted. This implies that the existence of this type of legislation would result in a drop in consumption of 0.109 packs (2.2 cigarettes) per capita.<sup>20</sup> Private workplace policy is shown to have a positive effect on sales, but is not significant at the 10 percent level of confidence.

Equation 2 incorporates the variables which take into account the incentive to smuggle from a state. The high price variable, the demand for bootleg cigarettes within a state from higher price border states, is of a very small magnitude and positively correlated with sales, but not statistically significant. The low price variable models the demand for substitutes, the lower priced cigarettes from bordering states. It is positively correlated with sales and of a larger magnitude than high price, but not statistically significant. The influence of Public policy increases by 0.001%. Private policy decreases by the same magnitude and remains statistically insignificant.

Equation 3 incorporates the effects of the incentive to engage in long distance smuggling with respect to regional price differences. Western states that engage in long distance smuggling will realize a decrease in apparent sales as the consumption of smuggled cigarettes rises. The distance of this region from the tobacco producing states with the lowest taxes accounts for the negative and statistically significant coefficient of this variable. The increase in apparent sales that occurs in those states which have the lowest regional tax rates models the effects of long distance smuggling. The variable for the lowest price in the Northeast represents the trend for New Hampshire and is of a considerable larger magnitude than the other two long distance variables. The substantial

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<sup>19</sup>Chaloupka and Saffer (1991) report price elasticity of -0.24 over the period 1975-1985. Baltagi and Levin (1986) estimate -0.22 for data over the period 1964 to 1980.

<sup>20</sup>Calculation based on a pack of cigarettes containing twenty cigarettes.

differential between New Hampshire tax rates and most of the other states throughout most of the period accounts for the sizable impact observed. Apparent sales rose by 0.55% or 13.7 cigarettes per capita. The third long distance dummy for lowest price in the South indicates a similar positive apparent consumption response, but of a lesser magnitude. This specification reduces the coefficients of both policy variables slightly, but does not affect their significance.

Equation 4 includes divorce as a proxy for stress. It is positively signed, but in this specification accounts for a 0.05% increase in sales (1.2 cigarettes per capita). It is significant at the 0.10 level of confidence. Price, income, and public policy parameters remain stable with this specification. Private policy and short distance smuggling remain insignificant. Equation 5 introduces the effect of educational attainment on consumption with the expected result of significantly decreasing consumption. A 1% increase in the educational attainment rate accounts for a 0.4% reduction in sales. This represents a decrease in per capita consumption of nearly ten cigarettes. The demand for substitutes, the lower price cigarettes in border states, becomes statistically significant at the 0.05 level of confidence with this specification. Price and income elasticities remain within expected ranges.

The full specification of the single equation demand function, equation 6, includes religious affiliation. It indicates a statistically significant reduction in demand of 0.04% for a 1% increase in the percentage of the population that adhere to Mormon or Southern Baptist religious beliefs. This represents a decline in sales of nearly one cigarette per capita. The high price smuggling variable, the demand for bootleg cigarettes within a state, becomes statistically significant at the 0.10 level of confidence; however, the magnitude of this effect remains negligible. A 0.0053% increase in sales that results from a 1% increase in the incentive for neighboring states to purchase bootleg cigarettes represents an increase in consumption of merely 0.13 cigarettes per capita. Public policy

continues to account for a 0.08% reduction in sales and Private policy remains statistically insignificant.

Long distance smuggling variables exert a statistically significant influence on apparent sales with each specification, but may be picking up some of the supply effects of transportation costs that are contained in the supply function and transmitted through the price mechanism. In equation 7, these variables are eliminated. In addition, anti-smoking legislation is collapsed into a single variable representing the existence of either type of legislation in that the effects of private workplace legislation do not account for any degree of statistical significance in any specification. When these changes are implemented, the random effects model is no longer indicated.<sup>21</sup> The fixed effect estimation of this specification is presented in equation 7.<sup>22</sup>

$$(7) \text{ LOGSAL} = \beta_1 - 0.609(\text{LOGPRI}) + 0.399(\text{LOGINC}) - 0.065(\text{POL}) + 0.0055(\text{LOGPH}) + 0.011(\text{LOGPL}) + \\ (-16.96)^* \quad (7.05) \quad (-6.23) \quad (1.44) \quad (2.04) \\ 0.09(\text{LOGDIV}) - 0.389(\text{LOGED}) - 0.065(\text{LOGREL}) + \varepsilon_i \\ (2.60) \quad (-6.27) \quad (-2.24)$$

$$R^2 = 0.574 \quad \text{F-statistic (zero slopes)} = 45.694$$

\*t-statistics represented in parenthesis

The policy effects are significant and account for a 0.065% reduction in sales, a magnitude less than that observed in previous specifications that included public restrictions. Coefficients for other variables remain consistent with results of previous specifications.

The effects of the enactment of anti-smoking legislation may not be realized instantaneously. To take into account the lagged effect of this policy, a variable was

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<sup>21</sup> A Hausman test of fixed effects versus random effects produce a P-value of .098 which indicates a failure to reject the null hypothesis of no correlation between the explanatory variables and the error term.

<sup>22</sup> See Appendix 2 for an explanation of variable abbreviations.

added to analyze the long term effects of its passage. Equation 8 represents the random effects panel estimates of this specification.

$$(8) \quad LSAL = 4.92 - 0.56(\text{LOGPRI}) + 0.440(\text{LOGINC}) - 0.043(\text{POL}) - 0.012(\text{LAGPOL}) + 0.0076(\text{LOGPH}) +$$

(13.4)\*      (-16.41)      (8.22)      (-4.04)      (-8.45)      (2.06)

$$0.02(\text{LOGPL}) + 0.041(\text{LOGDIV}) - 0.413(\text{LOGED}) - 0.025(\text{LOGREL}) + \varepsilon_i$$

(3.38)      (1.21)      (-7.51)      (-2.26)

$$R^2 = 0.595 \quad F\text{-statistic (zero slopes)} = 51.228$$

\*t-statistics represented in parenthesis

This equation implies that the lag in the amount of time the policy has been in effect accounts for a 0.01% reduction in sales, 30% less than the effects of initial impact, but of greater statistical significance. These results demonstrate the effects of the long run impact of the messages anti-smoking policies convey and indicate that a lag does exist in the manner in which smokers adapt to policy implementation.

### **Simultaneous Equations Analysis**

These results are interesting for a single equation model, but do not take into account the endogeneity of price, quantity or the policy variable. Given the near perfect multicollinearity between the policy variable and those state specific data series with little or no variation, a fixed effect simultaneous equations analysis is inestimable. Eliminating distance from the supply equation results results in a misspecification of the model but eliminates the perfect multicollinearity between distance and the policy variable. Two Stage Least Squares estimation results are reported in Table 3. Price elasticity of -0.8 is much higher than those estimates obtained in the single equation model. These results imply a reduction in sales of 0.8% for a one percent increase in price. Policy is insignificant at the 0.10 level of confidence. This introduces the argument that when

controlling for simultaneity, policy no longer exerts a significant influence on declining sales. Other variables in this model are consistent with expectations.

The supply model presents difficulty in interpretation as failure to address the endogeneity of the tobacco price may be contributing to the downward sloping supply function. The tobacco price variable is also signed in a manner inconsistent with economic theory in that the price of an input should be negatively correlated with sales of that product. Previous empirical work involving the tobacco market using simple specifications has produced similar results.<sup>23</sup>

**Table 3**  
**Two Stage Least Squares Results**

Panel Estimates

Variable	Coefficient*	t-statistic
<b>DEMAND</b>		
INT	4.370	4.60
LOGPRI	-0.802	-9.38
LOGINC	0.551	6.88
POL	-0.099	-1.23
LPH	0.0047	1.15
LPL	0.022	3.38
LOGDIV	0.064	1.58
LOGED	-0.274	-3.91
LOGREL	-0.029	-2.52
<b>SUPPLY **</b>		
LOGPRI	-0.257	-2.63
LOGTP	0.291	4.30
<b>LAW</b>		
INT	-7.34	-5.65
LOGSAL	-0.746	-5.654
LOGINC	1.09	7.50
LOGVOT	0.052	1.10
LOGED	0.247	1.29

\*coefficients reported as elasticities

\*\* Estimated with fixed effects model

The results of the Two Stage Least Squares analysis suggest that the single equation model produces interesting results but overstates the impact of policy on the demand for cigarettes. These findings also indicate that consumption is more responsive to

<sup>23</sup>Independent source at the United States Department of Agriculture.

changes in cigarette price than previous estimates imply, although to a degree that is still consistent with similar econometric analysis. The misspecification of the supply curve in conjunction with the endogeneity of tobacco price indicates the need for further econometric analysis. Full Information Maximum Likelihood (FIML) estimation was used to address these problems as it allows distance to be included in the specification of the supply function.<sup>24</sup>

Results of this procedure are reported in Table 4. These estimates use the demand specification of Equation 7 in a three equation model for demand, supply, and law, the linear probability of enacting the legislation. Price elasticity is slightly higher than, although consistent with the -0.57 elasticity obtained in the full specification of the single equation demand function. Income elasticity in the simultaneous model is significantly higher than the 0.35 elasticity of Equation 6 as it nearly doubles in magnitude. In the single equation model, the additive impact of both public and private policy accounts for a -0.066% decline in sales, a gross understatement of the impact predicted by the FIML estimate for policy. The FIML results indicate that policy reduces consumption by nearly 0.30%, a reduction of nearly 7.5 cigarettes per capita. The combined smuggling incentive is statistically significant and of a greater magnitude than the additive effects of the two short distance smuggling variables in the single equation model. These variables accounted for only a .01% reduction in demand and were not statistically significant without full specification. The coefficients for divorce and religion remain stable across the two methods of estimation. The impact of educational attainment diminishes by half in the full information model.

The supply model is interesting in that tobacco price, reflecting the costs of the primary input in the production of cigarettes that should be negatively correlated with sales, is positive. This indicates that failure to account for the endogeneity of this variable

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<sup>24</sup>While FIML estimation does not account for the panel structure of the data, similar empirical work has ignored this aspect. Despite the fact that the properties of FIML are not well understood, it is a feasible method of estimation that produces interesting results.

has biased the estimates. Given the complex structure of the subsidies that affect the tobacco market, modeling this variable in a structural equation to address its endogeneity is beyond the scope of this paper. Cigarette price is positively correlated with quantity supplied as predicted by economic theory. FIML results indicate that a 1% increase in cigarette price will result in a 2% increase in quantity supplied. Distance as a proxy for transportation cost is negatively correlated with sales and subscribes to the expectation that an increase in these costs will result in a 0.07% decline in quantity supplied.

**Table 4**  
**FIML Results**

Three Equation Model

Variable	Coefficient*	t-statistic
<b>DEMAND</b>		
INT	2.11	1.22
LOGPRI	-0.597	-8.93
LOGINC	0.673	6.02
POL	-0.295	-2.11
LOGSM	0.029	2.38
LOGDIV	0.165	7.34
LOGED	-0.260	-1.27
LOGREL	-0.051	-9.75
<b>SUPPLY</b>		
INT	-4.28	-2.98
LOGPRI	2.0	6.35
LOGTP	2.0	8.70
LOGDIS	-0.073	-6.14
<b>LAW</b>		
INT	-10.61	-8.58
LOGSAL	-0.453	-2.74
LOGINC	0.921	5.93
LOGVOT	0.195	2.87
LOGED	0.920	4.15

\*coefficients reported as elasticities

The linear probability model for the passage of the law predicts the effects that state characteristics will impose on the potential for passage of anti-smoking legislation. Sales have a negative effect on the probability of passage as they represent consumption



levels within the state. A state which includes a large number of smokers will be less likely to impose this type of restrictive legislation.<sup>25</sup> Income is positively correlated with probability and represents a component of the individual characteristics that contribute to the passage of this legislation. Voter participation is also positively correlated with policy and represents the level of political activity in a state. The FIML results indicate that a 1% increase in the rate of voter participation will increase the probability of anti-smoking legislation by 0.19%.<sup>26</sup> The results demonstrate that education has a significant impact on the probability of policy passage. Based on these results, a 1% increase in the educational attainment rate results in nearly a full percentage point increase in the probability of restrictive policy implementation.

The lagged effect of the policy was also addressed in a FIML Model. Results are reported in Table 5. They indicate that the length of the time the policy has been enacted is also a significant determinant of cigarette sales, although of considerably less magnitude than the initial impact of the legislation. In the lagged specification, educational attainment is no longer significant in the probability of the passage of legislation, but becomes statistically significant in the demand function. Given the empirically established correlation between education and health, this result demonstrates the significance of the long term impact of anti-smoking sentiment on the consumption of cigarettes. Subsequent regressions were run to analyze the joint impact of both the policy and the lagged effects. These specifications led to a situation whereby there was either difficulty with convergence or statistical insignificance of the policy variable due to the strength of the lagged effects.

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<sup>25</sup>This assumption presupposes that smokers are well represented in the voter population, and that sales are representative of the number of smokers, and not the quantity consumed per smoker. If individual consumption levels were the dominant factor in increased sales, an argument could be made for reverse causality of the sales variable on probability.

<sup>26</sup>A reverse argument could also be made for a negative correlation between voter participation and policy enactment if smokers represented the majority of voters in a state. However, given a participation rate that had declined to 27% by 1990, the argument seems implausible, a premise which the FIML results support.

**Table 5**  
**Lagged Policy FIML Results**

Three Equation Model

Variable	Coefficient*	t-statistic
<b>DEMAND</b>		
INT	2.64	2.05
LOGPRI	-0.543	-7.21
LOGINC	0.655	7.18
LAGPOL	-0.029	-2.43
LOGSM	0.035	3.76
LOGDIV	0.142	6.04
LOGED	-0.415	3.21
LOGREL	-0.044	-7.90
<b>SUPPLY</b>		
INT	-4.53	-2.99
LOGPRI	2.06	6.19
LOGTP	2.05	8.41
LOGDIS	-0.078	-6.09
<b>LAW</b>		
INT	-67.4711	-6.66
LOGSAL	-8.07	-6.45
LOGINC	10.0	9.38
LOGVOT	1.87	3.16
LOGED	2.15	1.09

\*coefficients reported as elasticities

A FIML model was also estimated to incorporate the effects of time by introducing time dummies to the demand specification. This specification resulted in price elasticity greater than one, and a sign reversal for the smuggling variable. The time dummies may have been picking up some of the year specific effects which contribute to the incentive to engage in border state smuggling. Elimination of this variable from the demand equation produced results which are reported in Table 6.

These results confirm that the initial impact of the policy is the most significant determinant in the reduction of cigarette consumption. These estimates also indicate a shift in consumption in 1984. Holding all other effects constant, consumption in 1984 rose relative to 1983. This trend continues until the end of the period with significant

t-statistics throughout this time. By taking into account year specific effects, this specification robs educational attainment of any statistical significance.<sup>27</sup>

**Table 6**  
**Time Dummy FIML Results**

Demand Function

Variable	Coefficient*	t-statistic
INT	3.97	2.14
LOGPRI	-1.23	-6.23
LOGINC	0.629	5.75
POL	-0.45	-3.40
LOGDIV	0.146	5.78
LOGED	0.106	0.528
LOGREL	-0.054	-6.78
1976	.0477	3.37
1977	-0.023	-1.71
1978	.00277	0.198
1979	-0.082	-4.27
1980	-0.150	-5.29
1981	-0.216	-5.79
1982	-.00941	-0.586
1983	-0.00941	-0.586
1984	0.115	4.91
1985	0.095	4.17
1986	0.100	3.61
1987	0.137	4.20
1988	0.169	4.53
1989	0.180	4.18
1990	0.195	4.07

\*coefficients reported as elasticities

The change in the price elasticity of demand is an interesting development that evolves as a result of this specification. Demand elasticity greater than one is counter-intuitive and refutes the majority of empirical evidence. The introduction of year specific dummies is the only specification estimated that precipitates this response.

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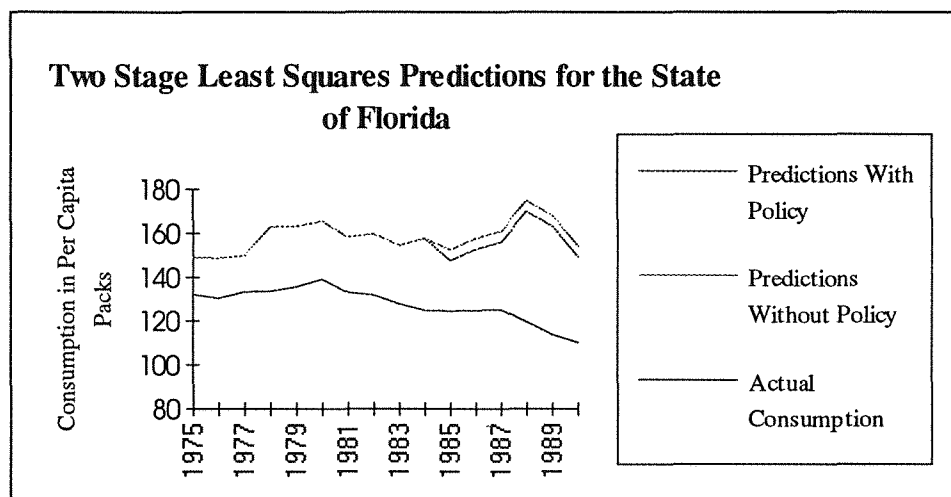
<sup>27</sup>This variable does become statistically significant in the probability demand for the policy with a magnitude of 0.735, a result consistent with the specification that includes only the policy variable.

The FIML estimates ignore the panel structure of the data and may have either some state specific component to the error term or be picking up the effects of auto-correlation. This method then produces consistent estimates, but ones that are no longer efficient. This bias in the error term inflates the statistical significance of the coefficients, causing some doubt as to the statistical validity of this analysis. However, given the constraints inherent to the data set, it is a valid method of estimation.

## V. Conclusions

The effects of anti-smoking legislation on cigarette sales based upon the results of the Two Stage Least Squares results which take into account the panel aspects of the data are of statistical significance, but appear to have no appreciable effect on the magnitude of consumption. Figure 5 illustrates the accuracy with which these estimates predict actual consumption levels.

Figure 5

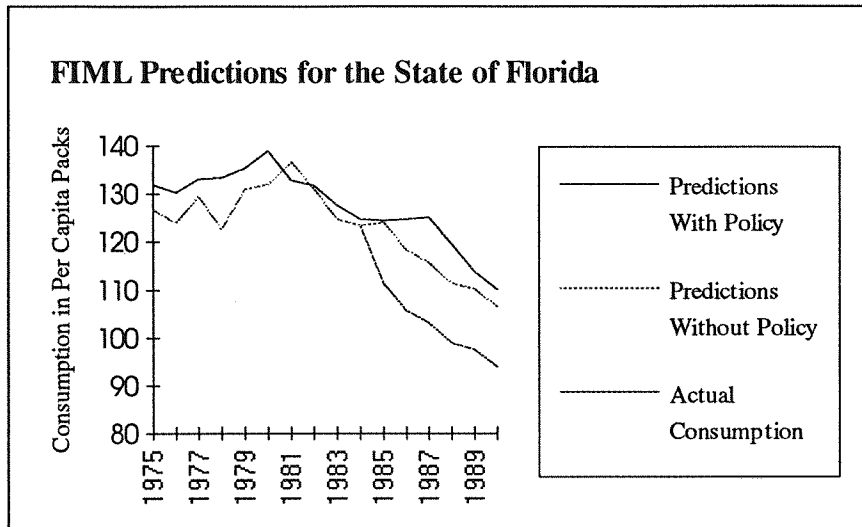


These estimates overstate consumption throughout the period, with the magnitude of this bias increasing with time. The model does tend to predict most movement in sales prior to the enactment of the policy, but predicts an increase in consumption after the initial decline that accompanied the passage of legislation in 1985 that directly conflicts with expectations.

The results from the Full Information Maximum Likelihood model conform more accurately to actual consumption. Figure 6 illustrates the relative accuracy with which the model predicts cigarette sales for the state of Florida. The adoption of anti-smoking policy in 1985 marks a continuation in the trend of declining consumption; however, this model overstates the magnitude of the decline. The decline in sales as a result of the

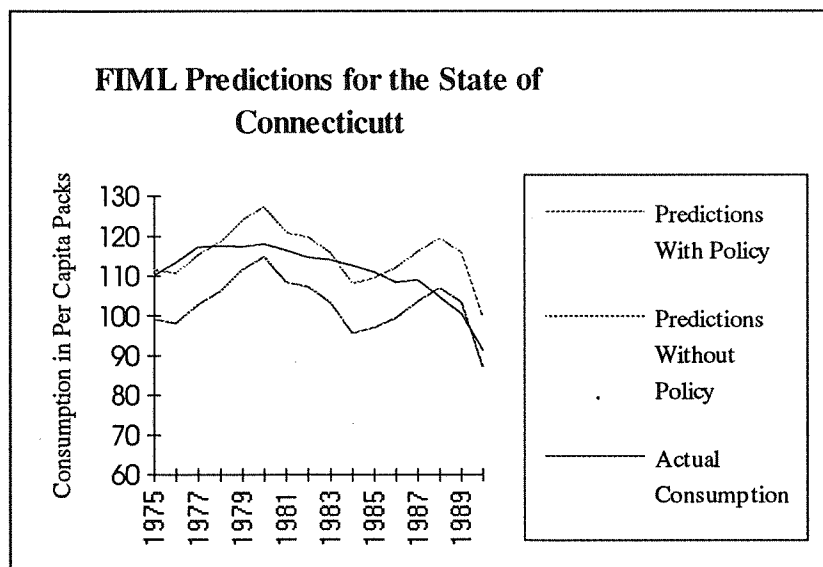
policy appear to occur with a lag of approximately one year. This is consistent with other models which attribute statistical significance to the lagged effects of restrictive policy.

Figure 6



Predictions for the state of Connecticut are reported in Figure 7. This state had restrictions in place throughout the period and the predictions with and without policy implementation frame actual consumption levels. This illustrates the accuracy of the

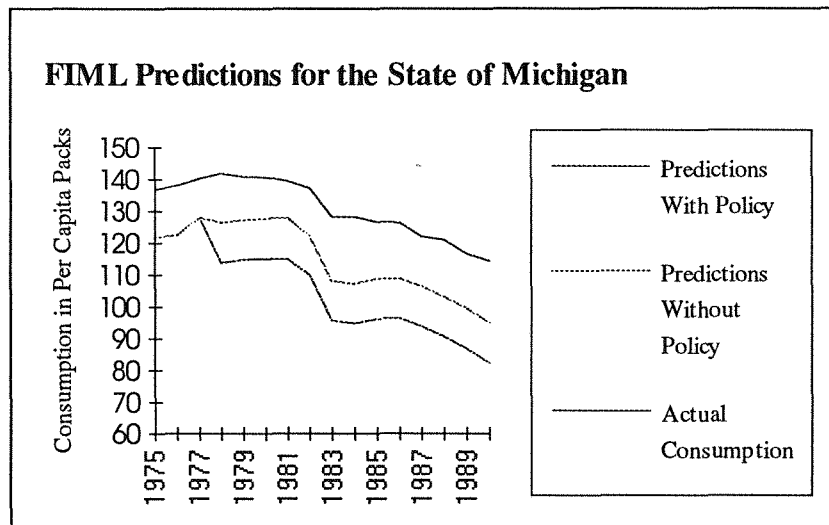
Figure 7



FIML estimates, but demonstrates once again the bias with which these estimates predict consumption. They overstate the reduction in consumption throughout most of the period, increasing in precision after 1988. The state of Connecticut experienced declines in cigarette consumption throughout most of the period that is consistent with the existence of these types of smoking restrictions.

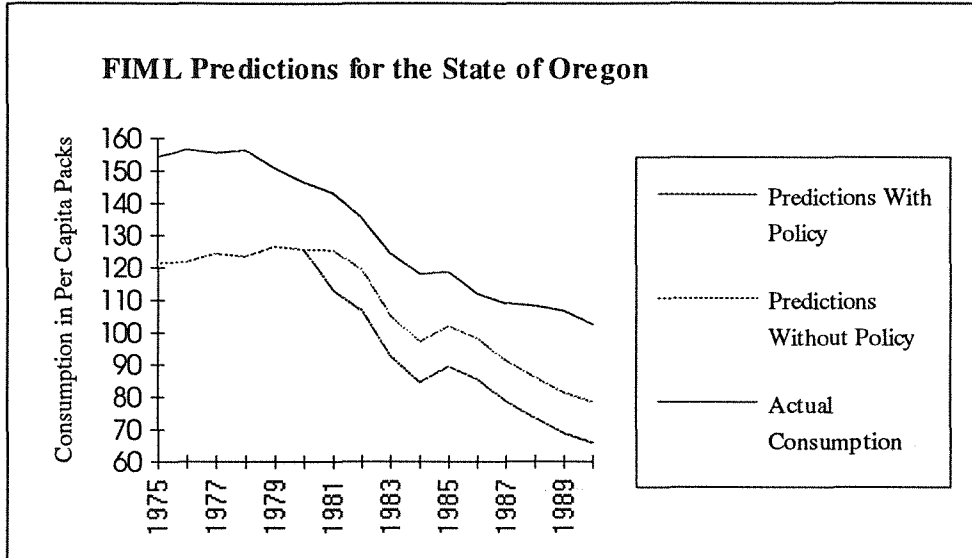
An analysis of the state of Michigan with respect to policy illustrates the lagged effects of the policy well. Figure 8 illustrates that the implementation of anti-smoking restrictions in 1978 prompted no immediate response in actual consumption levels. The FIML estimates very closely trace the pattern of consumption with a fairly constant downward bias. Consumption begins to decline very gradually after the policy is adopted, and at an increasing rate in subsequent years.

**Figure 8**



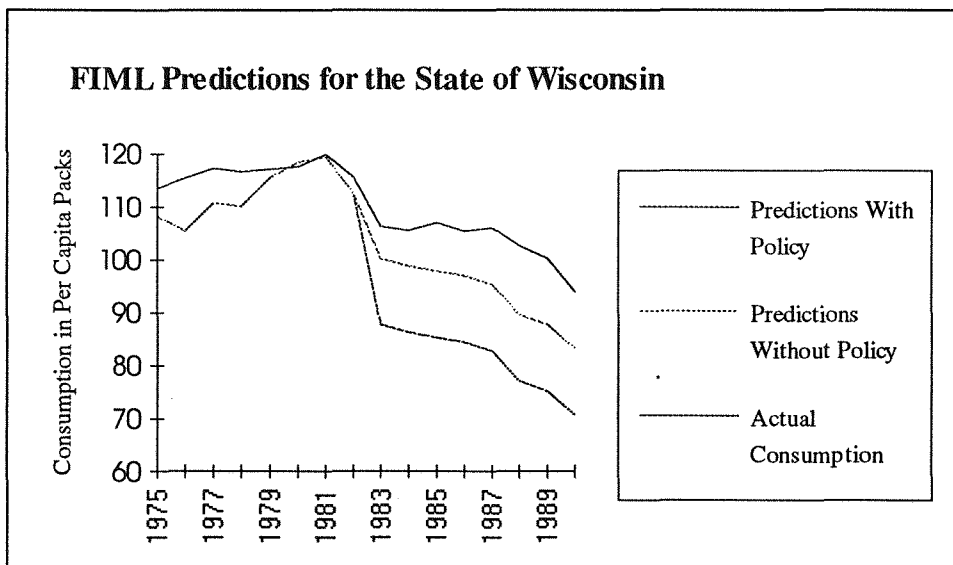
Estimates for the state of Oregon are reported in Figure 9. They illustrate a more significant bias in estimation, but indicate an impact of less significant magnitude for the implementation of policy. The precision of these estimates tends to increase as the period progresses.

Figure 9



The state of Wisconsin is also interesting in that although predictions in the presence of the policy somewhat overstate the impact of anti-smoking restrictions, this state was experiencing a decline in the level of consumption prior to the enactment of legislation.

Figure 10





This suggests the possibility that the behavior that characterizes a given state may influence the adoption of anti-smoking policy to a greater degree than the existence of the policy determines consumption behavior. Social trends may be reflected in the enactment of this type of legislation in a manner consistent with falling levels of cigarette sales.

All of these results seem to suggest that anti-smoking restrictions impart a negative and statistically significant impact on the consumption of cigarettes. The strength of the relationship has been adequately established; however, whether the causal factor is the characteristic behavior inherent of a given state or the direct influence of policy once it has been adopted is uncertain and is an area that warrants further research. Public policy restrictions induce significant reductions in consumption of cigarettes in the states in which they have been enacted, while the effects of private place restrictions appear relatively ineffective. Both types of restrictions promote a message to smokers of the inherent dangers of their consumption habits. The lag with which this sort of information is responded to has been well established empirically, and is a possible explanation for the insignificance of private restrictions given the relatively short period of time in which most of them have been in effect.

Another possible explanation lies in the attitudes of smokers in general. The addictive nature of cigarettes in combination with the rational choices smokers make with respect to future stocks of health indicates that some smokers may continue their consumption levels despite restrictions. They do so either by attempting to avoid the restrictions by circumventing restricted areas, or by compensating for reduced consumption through increased levels of smoking in an unrestricted environment.

The results of the price elasticity analysis are encouraging for the Clinton administration as it contemplates imposing additional taxation of cigarettes as a method to generate revenue to finance health care reform. Defense of this method relates to the burden that smokers would place on a national health care system due to the physical risks of a chronic nature that are incurred as a result of smoking. Empirical evidence suggests

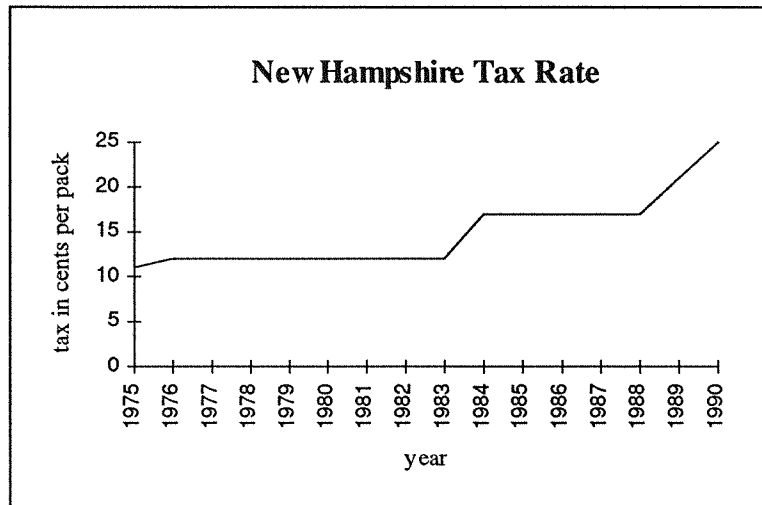
that as a group, smokers more than compensate for future health expenditures through the amount of excise taxes they pay. This is largely a result of decreased life expectancy given the nature of the diseases which smokers most frequently contract as a direct result of their habit.

The policy of adopting anti-smoking legislation is highly controversial. In the name of insuring non-smokers the right to breathe clean air, these restrictions challenge the rights of smokers to consume a legal substance in public as well as in their places of employment. The results of this study indicate that the magnitude of the impact of anti-smoking legislation at the state level accounts for less than a 0.5% decrease in sales. If policy makers are implementing these restrictions as a means to promote good health, their attempts at reducing aggregate consumption have not been overwhelmingly successful to date. However, should the trend in the adoption of these policies continue, the educational effects of the messages these policies convey may in fact surpass the direct effects of the restrictions, leading to an overall reduction in the number of smokers and a healthier population.

## VI. Appendices

### Appendix 1

Figure 11



Source: The Tobacco Institute

The state excise tax rate for New Hampshire remained constant at a rate well below regional tax rates for the first nine years of the period. Recent increases in tax rates have brought the state to levels comparable with other surrounding states. However, the effects of this phenomenon were sufficient to account for substantial smuggling from the state of New Hampshire for much of the period.

## Appendix 2

An explanation of the abbreviations of the variables used in equations discussed in the text is included to enhance the clarity of the presentation of results.

INT	Intercept
LOGSAL	Log of cigarette sales
LOGPRI	Log of real state tax-paid cigarette price
LOGINC	Log of personal disposable real income
POL	Enactment of either public or private restriction
LAGPOL	Trend of the time since restriction was enacted
LOGPH	Log of the index of the incentive to purchase bootleg cigarettes within a state
LOGPL	Log of the index of the incentive to purchase bootleg cigarettes from border states
LOGSM	Log of the total incentive to engage in short distance casual smuggling
LOGDIV	Log of the divorce rate within a state
LOGED	Log of the rate of educational attainment within a state
LOGREL	Log of the percentage of Mormons and Southern Baptists within a state
LOGTP	Log of the real average tobacco price paid to farmers
LOGDIS	Log of the distance from Norfolk, Virginia to state capital
LOGVOT	Log of the percentage of total population that vote within a state

Appendix 3

**Table 7**  
**Public and Private Policy Adoption**

State	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990							
Alabama	0*	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
Alaska	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x							
Arizona	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
Arkansas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0							
California	0	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x							
Colorado	0	0	x	x	x	x	x	x	x	x	x	x	x	x	x	x							
Connecticut	x	x	x	x	x	x	x	x	x	x	y	x	y	x	y	x	y	x	y				
Delaware	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
D.C.	0	0	0	0	x	x	x	x	x	x	x	x	x	x	y	x	y	x	y				
Florida	0	0	0	0	0	0	0	0	0	0	x	y	x	y	x	y	x	y	x	y			
Georgia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Hawaii	0	0	0	0	0	0	0	0	0	0	0	0	x	x	x	x							
Idaho	0	0	0	0	0	0	0	0	0	0	x	x	x	x	x	x							
Illinois	0	0	0	0	0	0	0	0	0	0	0	0	0	0	x	x							
Indiana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Iowa	0	0	0	0	0	0	0	0	0	0	0	0	x	y	x	y	x	y	x	y			
Kansas	0	0	0	0	0	0	0	0	0	0	0	0	x	x	x	x							
Kentucky	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Louisiana	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Maine	0	0	0	0	0	0	0	0	0	0	y	y	x	y	x	y	x	y	x	y			
Maryland	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Massachusetts	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
Michigan	0	0	0	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x			
Minnesota	x	y	x	y	x	y	x	y	x	y	x	y	x	y	x	y	x	y	x	y	x	y	
Mississippi	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Missouri	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
Montana	0	0	0	0	x	y	x	y	x	y	x	y	x	y	x	y	x	y	x	y	x	y	
Nebraska	0	0	0	0	x	y	x	y	x	y	x	y	x	y	x	y	x	y	x	y	x	y	
Nevada	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x		
New Hampshire	0	0	0	0	0	0	0	0	0	0	0	0	x	y	x	y	x	y	x	y	x	y	
New Jersey	0	0	0	0	0	0	0	0	0	0	x	y	x	y	x	y	x	y	x	y	x	y	
New Mexico	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
New York	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	x	y	x	y	x	y	x	y
North Carolina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
North Dakota	0	0	0	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Ohio	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Oklahoma	0	0	0	0	0	0	0	0	0	0	0	0	x	x	x	x							
Oregon	0	0	0	0	0	0	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

\* where 0 = no policy, x = public policy, and y = private policy

**Table 7 (continued)**

State	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990					
Pennsylvania	0	0	0	0	0	0	0	0	0	0	0	0	0	x	y	x	y	x	y		
Rhode Island	0	0	0	0	0	0	0	0	0	0	0	0	x	y	x	y	x	y	x	y	
South Carolina	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
South Dakota	0	0	0	0	0	0	0	0	0	0	0	0	0	x	x	x	x				
Tennessee	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	x	
Texas	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Utah	0	x	y	x	y	x	y	x	y	x	y	x	y	x	y	x	y	x	y	x	y
Vermont	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Virginia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	x	
Washington	0	0	0	0	0	0	0	0	0	0	0	x	x	x	x	x	x	x			
West Virginia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Wisconsin	0	0	0	0	0	0	0	0	x	y	x	y	x	y	x	y	x	y	x	y	
Wyoming	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

Source: Coalition on Smoking or Health

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