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Abstract

A framework for the optimal taxation of cigarettes based on economic efficiency is provided here. Fundamentally different views of smoking in the context of addictive behavior result in markedly different estimates of the efficient cigarette tax rate. Based on the rational addiction model, more than half of the states may have increased their cigarette excise tax rates to levels beyond the economically

efficient point. But if many smokers have time-inconsistent preferences, cigarette tax rates well beyond \$1 per pack may be justified.

Introduction

Adam Smith noticed, “Sugar, rum, and tobacco are commodities which are nowhere necessities of life, which are become objects of almost universal consumption, and which are therefore extremely proper subjects of taxation” (Smith, 1789, Book 5, Chapter 3, V.3.76). Recently, state governments experiencing budget shortfalls have embraced this maxim in alleviating financial shortfalls. From 2001 through 2003, more than 30 states implemented cigarette tax hikes of unprecedented magnitude. By the end of 2003, state per pack cigarette excise tax rates ranged from 2.5 cents in Virginia to \$2.05 in New Jersey. The average state cigarette excise tax rate in the U.S. increased from 42 cents in 2001 to 73 cents per pack in 2003. The number of states levying excise taxes of \$1 or more per pack increased from 3 in 2001 to 16 in 2003. In 25 states, smokers faced combined federal (39 cents) and state per pack cigarette taxes of \$1 or more (Federation of Tax Administrators, 2004).

The outcome of cigarette tax legislation has been dominated by the goal of revenue-maximization and by the opposing interests of powerful lobby groups, such as the tobacco industry and the health community. The role of cigarette taxes in promoting economic efficiency and social welfare has been given only peripheral consideration in determining the appropriate tax rate. This study's aim is to help fill the gap by providing an economic framework for the optimal cigarette taxation based on economic efficiency theory.

Initially outlined are the economic justifications for the taxation of cigarettes, with an emphasis on how various economists view the addictive nature of cigarette smoking. Two addiction models, the rational addiction model (Becker and Murphy, 1988) and the time-inconsistent approach (Gruber and Koszegi, 2001/2002), with fundamentally different implications for the efficient taxation of cigarettes are presented. Estimates of the efficient cigarette tax rate based on both addiction models are then presented.

Economic Efficiency and Social Welfare

Economic efficiency describes the state in which the available resources of a society are allocated in a way that maximizes society's welfare. A market is Pareto-efficient when no one can be made better off without making someone else worse off. Perfect competition among economic agents when prices reflect marginal social costs and benefits insures Pareto efficiency (Mair and Miller,

1991). However, markets do not always meet such conditions, i.e., market failures exist. Public policy, such as cigarette taxes, can, at least in theory, impact social welfare by moving an economy towards the Pareto-efficient state (Mair and Miller, 1991). However, such actions favorably affect some individuals while unfavorably affecting others. For example, a tax on cigarettes designed to improve economic efficiency does not per se constitute a Pareto-efficient move because income will be redistributed from smokers to non-smokers. While taxed smokers could be compensated for their income losses, such actions rarely occur. Economists have responded with the concept of the potential Pareto-efficient move where gains to the winners are seen as exceeding costs to the losers thus enhancing efficiency and ultimately social welfare.ⁱ

Market Failures in Cigarette Smoking and Efficient

Market failures with respect to cigarette consumption can occur in the form of externalities, incorrect risk perception, and addictive behavior (Jeanrenaud and Soguel, 1999). When the detrimental effects of market failures on social welfare are considerable, it may be proper for government to bring consumption closer to the Pareto-efficient level through a selective excise tax. This section describes the market failures that may occur in cigarette consumption and explains in theory how excise taxes can be used to correct them.

Externalities

Externalities are a cost (benefit) that a transaction imposes on economic agents without the receiver of the externality being compensated (charged). If externality-based costs exceed externality-based benefits, social welfare is reduced (Baumol 1972). Cigarette consumption can be seen as imposing externalities through greater health care system costs based on increased use due to smoking, the effects of second hand smoke, and lost worker productivity. If such externalities do exist, smokers will make consumption decisions that are socially inefficient with the difference between the Pareto-efficient consumption level and the actual consumption leading to a loss in social welfare.

When externalities exist and bargaining between individuals to reach a solution on their own has a high transaction cost, government might be better suited to facilitate the internalization of externalities through Pigouvian taxes (Pigou, 1962), thus bringing consumption closer to the Pareto-efficient level by raising the price (Holcombe, 1996). With regard to cigarette consumption, selective taxes may raise the price for cigarettes to the level where the costs imposed by smokers on others are incorporated.

Economists opposed to cigarette taxes reply that smokers do not impose costs on nonsmokers (Tollison and Wagner, 1988). They argue that impacts on the health care system occur only because government health care programs

inappropriately include smokers and nonsmokers in the same health insurance pool. Thus, health care cost arguments justify a wrong with a wrong. They also argue that over their lifetime, smokers impose no additional cost on the health care system than do nonsmokers. Lost productivity studies related to smoking are seen as flawed. If such costs do occur, they are reflected only in private wage rates and thus do not constitute an externality. They also indicate that exposure to second hand smoke is voluntarily. For example, non-smokers exposed to work-related second hand smoke voluntarily work in such places and receive higher wage rate that compensate for any subsequent damage.

Theoretical arguments can be made that smokers do impose costs on others. Accepting the o-ring theory of labor productivity (Kremer, 1993), productivity and hence wages for a given worker are a function of not only their efforts, but also the productivity of their fellow workers. Therefore, productivity losses by a smoker could impose a cost on their fellow workers. The theories of second and third best indicate that even under conditions where economic efficiency is not obtained, improvements can still be made through smaller changes (Ng, 1980). Hence, health care system costs should count in evaluating the impact of smoking. With respect to the empirical issues surrounding productivity loss and health care system use, the best research indicates that such costs are substantial. For example, a study conducted by Halpern et al. (2001) found that former smokers and those who have never smoked had significantly reduced rates of absenteeism and higher productivity levels as compared to smokers at the reservation office of a major U.S. airline. A study conducted by Manning et al. (1989), which forms the core of the calculations used in this study, showed significant impacts on costs in the health care sector.

Opponents also make the argument based on Coase (1960) that second hand smoke related impacts are a property rights issue with reciprocal damages. For example, in a restaurant where smoking is an issue, individuals precluded from smoking would experience a negative externality as would involuntary breathers of smoke. In such situations, the property rights to air quality should be assigned to a given side, and then an efficient solution can be arrived at via volunteer negotiations (with the holder of the right monetarily compensated by damage imposed by the other side). If smoking is banned or even reduced, smokers should be compensated for not being allowed to use the resource (air quality) in a way that they desire. However, Coase assumed that such bargains occur without any transactions cost. Economists who question this solution point out that facilitating a bargain or trade over rights to smoke in restaurants and other settings between the large numbers of people involved would be so costly as to override any resulting gains in social welfare.

Incorrect Risk Perception

In a perfect market, economic agents are assumed to be fully rational, meaning they possess adequate knowledge on which to base decisions and use

such knowledge to maximize their long-term welfare. Thus, imperfect knowledge about the costs and benefits of consuming a good can constitute a market failure. For example, if smokers are not fully informed about the health risks of smoking, they are unaware of their own (internal) costs and will tend to consume more than the Pareto-efficient quantity. When consumers are not fully rational due to incorrect risk perceptions, government may appropriately close the information gap, e.g. through public information campaigns concerning associated risks. Consumers subsequently adjust their consumption decisions to be more in line with the Pareto-efficient level. With regard to cigarette consumption, a tax on cigarettes may be levied aiming at signaling to smokers those costs of smoking which they have not recognized correctly. A cigarette tax could reduce consumption to the levels consumed under complete information.

Addictive Behavior

Addictive behavior may prevent consumers from making rational choices. If consumers are irrational in deciding to smoke (that is, not acting in their long-term best interest) a market failure may occur. Addiction is characterized by the tendency that past consumption raises present consumption because past use of the substance raises the marginal utility of present consumption. In such cases, an increase in past consumption of the good leads to an increase in current consumption (Grossman, Chaloupka, and Anderson, 1998). To an addicted smoker, one benefit of smoking is to prevent nicotine withdrawal. Therefore, past consumption tends to encourage present use.

Until the mid 1980s, economic theory mostly modeled addiction as habit formation. Addicted consumers were viewed as being myopic. It was assumed that current consumption increases future consumption but that addicts ignored the effects of current consumption on future welfare. The consumption of addictive goods was seen as being entirely unresponsive to price changes. Thus, addictive behavior was viewed as irrational and did not fit in the context of standard economics (Chaloupka and Warner, 2001). This view changed with the work of Becker and Murphy. Their approach modeled addiction in the context of rational behavior and became standard among economists. More recently, attempts have been made to model addiction as time-inconsistent behavior. While following the work of Becker and Murphy to a large extent, the approach makes alternative key assumptions, which lead to different conclusions regarding the optimal taxation of cigarettes.

Becker and Murphy in their rational addiction model presume that smoking builds an addictive stock. An increase in consumption today increases the addictive stock in the future. A high addictive stock lowers the average utility of smokers in the future because smoking is harmful. However, a higher addictive stock also increases the addict's marginal utility derived from smoking. That is, the higher the addictive stock, the more the addict craves another cigarette. The key aspect of any addiction model is how addicts deal with this

intertemporal problem. Becker and Murphy deal with this problem by making the assumptions that addicts are forward-looking and time-consistent.

Addicts are forward-looking because current consumption depends on past and future consumption. As forward-looking consumers, smokers trade off the utility gains from smoking against the costs of doing so. Smokers derive utility from pleasure, status within their social group, and so forth. Costs that smokers take into account are the monetary price of cigarettes, current damage that they are doing to themselves through smoking, and the additional future damage caused by ongoing future consumption. These rational addicts discount future utility and costs exponentially and therefore have time-consistent preferences. Their relative preference for well-being at an earlier date over a later date is assumed to be the same for any point in time. Discounting future net utility with more distant effects receiving less weight, addicts arrive at either a positive or a negative net utility from smoking and rationally act accordingly in their current smoking decisions. Consumption of addictive goods is governed by the same rational decision-making process as other goods (Gruber and Mullainathan, 2002). Thus, smokers are fully aware of the potential of becoming addicted when they make their smoking decisions. Based on the rational addiction model, addiction per se does not constitute market failure and the costs smokers impose on themselves are irrelevant for taxation unless rooted in misperceptions about the harmfulness of smoking.

In some ways the rational addiction model has been reinforced by the empirical literature. Studies have generally shown that addicts are forward-looking with present consumption of addictive goods depending on past and future consumption. In particular and as expected with forward-looking addicts, higher future prices have been shown to lower current consumption (Gruber and Koszegi, 2001).

However, the model has been challenged for two main reasons. First, consumers may lack perfect foresight, especially when they first begin to smoke cigarettes. Each individual possesses a subjective understanding of his potential to become addicted and this understanding develops as the individual consumes the addictive good. Therefore, an individual who underestimates the potential of becoming addicted may end up regretting his past decisions. Evidence from observing the behavior of young smokers suggests that they often underestimate the addictive nature of smoking (Chaloupka and Warner, 2001). Second, the very assumption of time-consistency is questioned. Casual observation, introspection, and psychological research all suggest that the assumption of time consistency is inappropriate. Instead, humans tend to realize immediate rewards and avoid immediate costs in a way that does not maximize their long run utility (O'Donoghue and Rabin, 1999). Both criticisms are addressed in the approach of time-inconsistent addictive behavior by Gruber and Koszegi.

Gruber and Koszegi retained the stock addiction framework and forward-looking addicts assumption of Becker and Murphy. However, they rejected the assumption of time-consistent preferences; instead they argued that the past literature has merely shown that smokers are not fully myopic and that the key time-consistency premise has not been tested.

Gruber and Koszegi model addicts to be time-inconsistent and to discount future utility in a quasi-hyperbolic fashion. Formally, discounted utility is seen as

$$(1) U_t + b^{T-t} \sum_{n=1} d^n U_{t+n}$$

where U_t is utility in the current period, U_{t+n} is an index reflecting future utility over all periods in the time horizon T , which is summed over all future time periods, and b and d are parameters assumed to be between zero and one. (The parameter d is the standard per-period time discount factor.)

Addicts discount the next period forward by bd , the following period by bd^2 , and n periods in the future by $b^{T-t} d^n$, where $b < 1$ is an extra discount factor that changes the discounting of this period relative to the future. Since the discount factor of this period is bd and the relative discount factor between future periods is $d > bd$, the individual gives a greater relative weight to this period than to any later one. As such, individuals are assumed to be impatient (Gruber and Mullainathan, 2002).

The key implication of such a hyperbolic model is that addicts are assumed to have self-control problems. Individuals who discount hyperbolically would like to smoke less in the future than they actually end up doing. Whereas their long-run preference suggests a lower consumption level of the harmful good to increase long-run utility, the immediate preference is to increase consumption to derive instant utility from smoking. Thus, although addicts would like to smoke less in the future from today's standpoint, they end up making impatient decisions when the future arrives, which prevents them from maximizing long-run utility. This behavior represents a major deviation from the concept of fully rationally agents and can be viewed as a form of market failure that is attributed to addiction. Within the framework of time-inconsistent addictive behavior, Gruber and Koszegi (2002) specify two extreme types of time-inconsistent individuals: "sophisticated hyperbolic individuals" and "naive hyperbolic individuals."

Sophisticates are aware of their self-control problem and therefore know that they will change their preference in the future. To quit or reduce smoking, they frequently try to combat this problem by using self-control devices, such as betting with others, telling others about their decision to quit, and making it otherwise embarrassing to smoke. A self-control device reduces the utility derived from smoking. Taxes can also serve as a self-control device by helping sophisticates actualize their long-run preferences of less smoking.

Naives would also like to smoke less in the future, and also have self-control problems. However, in contrast to sophisticates, they are unaware of their self-control problem. Thus, they do not choose self-control devices. Naives typically have a misperception problem regarding their desired (predicted) future smoking levels. They believe that their preference in the future will be identical with their current preference. For example, smokers who express the desire not to smoke a certain time from today are unaware that they will change their mind when the future arrives. For young smokers, there is clear evidence that they underestimate the future likelihood of smoking (Gruber, 2001; Romer and Jamieson, 2001).

Taxes serve naives not only as a self-control device but also help them correct the misperception problem regarding their time-inconsistency (Gruber and Koszegi, 2002). Since approximately 80% of all smokers adopt their habit before the age of 20 years (Evans, Ringel, and Stech, 1999), the misperception problem can be closely linked to the underestimation of the addictive potential of smoking.

The proposition of time-inconsistent addictive behavior is supported by compelling evidence. First, a large body of laboratory experiments overwhelmingly document that consumers are time-inconsistent. Consumers consistently exhibit a lower discount rate for decisions on time intervals further away than for ones closer to the present. They tend to realize immediate rewards but delay uncomfortable experiences to the future (Gruber and Koszegi, 2002). Second, the calibration of real world behavior against models with and without time-inconsistency confirms the prevalence of self-control problems in decisions such as consumption versus saving. Also, with regard to smoking decisions, the observation of quitting behavior points to time-inconsistent preferences. A time-consistent smoker makes the decision to smoke or to quit and follows through. However, eight of ten smokers in America wish to quit but most of the intentions are not actualized, which indicates time-inconsistent smoking preferences (Gruber and Koszegi, 2002). Third, Gruber and Mullainathan show in an econometric test that higher levels of cigarette excise taxes raise self-reported well-being among smokers but not among non-smokers. The time-inconsistent model can explain this observation, as it provides the self-control device time-inconsistent addicts value; the time-consistent model cannot, because cigarette taxes make time-consistent addicts worse off.

Based on the rational addiction model, consumption of addictive goods is governed by the same rational decision-making process as other goods. As such, only the externalities and internal costs due to incorrect risk perception are subject to taxation. However, based on time-inconsistent addictive behavior, addictive behavior does constitute market failure and by itself serves as a justification for cigarette excise taxes which provide a form of self-control and correct for time-inconsistent preferences. Arguably, (Gruber and Koszegi, 2002) appropriate self-commitment devices could be provided via the market system or

by individuals themselves (i.e., the self-control mechanisms like betting with others). However, market-provided self-control mechanisms are likely to be offset by the market. As some firms develop effective self-control devices, other firms have the financial incentive to break them down. Privately provided self-control mechanisms are likely to run into enforcement problems. Therefore, government is the only institution that can effectively provide such self-control devices.

The Efficient Cigarette Tax Rate and the Rational Addiction Model

The efficient cigarette tax rate based on the rational addiction model is estimated here. Social costs are divided into internal costs borne by smokers and external costs borne by others with the former a candidate for appropriate taxation. Various social cost-of-smoking studies have included direct costs, consisting of health care costs associated with all smoking-related diseases, indirect costs, which capture the value of the loss of human capital due to smoking, and intangible costs, which capture the value of life lost due to smoking-related death or disease (Jeanrenaud and Soguel, 1999).

Three essential criteria must be fulfilled for social cost-of-smoking studies to correctly assess the efficient cigarette tax rate (Gravelle and Zimmerman, 1994). Analysis indicates that among social cost-of-smoking studies only the study by Manning et al. meets these criteria. First, the costs of smoking must be assessed via the incidence-based approach, which determines the present value of the additional lifetime costs of cohorts of present smokers. The incidence-based approach captures the long lags between smoking initiation and most smoking-related illnesses. But the widely used prevalence-based model measures the smoking related costs in a given year, which reflect historical trends in smoking and therefore lead to an incorrect tax rate. Second, external costs must be distinguished from internal costs. Also, smokers' excess costs during their lifetime must be set off against savings resulting from premature smoking-related death. While savings from government transfers due to premature death do not imply that there is a social gain from premature death (Gravelle, 1998), the government, as provider of certain services, will experience financial savings from premature death, which must be considered in determining how different parties fare because of smoking. Third, other attributes of individuals than smoking that influence external costs, such as education, income, and other health habits, should be statistically controlled for in isolating the effect of smoking. In particular, Hersch and Viscusi (1998) found that teenage and adult smokers are more prone to take risks than non-smokers. For example, fewer smokers wear seat belts and smokers tend to take riskier jobs without demanding higher economic compensation.

The Manning et al. study calculates the external costs of smoking for various discount rates by comparing the lifetime costs and savings of cohorts of

20-year-old smokers to cohorts of “non-smoking smokers” of the same age. The data used stems from nationwide surveys, such as the 1983 National Health Interview Survey (NHIS). The study distinguishes between internal costs and external costs. The externalities per pack are calculated by dividing the discounted expected lifetime net externalities of a cohort of smokers by the number of packs smoked in a lifetime.

Valuing External Costs

Externalities are comprised of financial costs associated with the impact of smoking on the costs of healthcare, group health and life insurance, pensions, and other collectively financed programs and health and of other costs resulting from exposure to environmental tobacco smoke (ETS). Values of cost components from the Manning et al. study used here are inflated to 2003 dollars. The Medical Services Index (U.S. Department of Labor, 2004) is applied for health care related cost components while the GNP deflator (U.S. Department of Commerce, 2004) is used for all other costs. Additional cost components omitted in Manning et al. are also included when appropriate.

Excessive medical costs of smokers are considered to be external costs. These cost include those borne by collectively financed health care programs, increased costs on collectively financed disability insurances, payments workers receive from collectively financed programs while absent, e.g. social security, death benefits from group life insurances due to increased mortality, foregone taxes paid on wages to finance retirement and public health programs due to premature death, and all property damage from smoking-related fires paid by uniformly financed fire insurance. External savings due to smokers’ average shorter life span of 6.1 years (Gruber and Koszegi, 2002) include medical cost savings, pensions not paid because of premature death, and shorter utilization of collectively financed nursing homes. Wages foregone due to smoking-related work absence or death are considered internal and as such not subject to taxation because they are borne by the smoker. The value of the more than one thousand lives lost in fires is considered internal because nearly all deaths are in the family (the standard unit in consumption studies).ⁱⁱ

The link between passive smoking and adverse health effects is now well established (World Health Organization Europe, 2001; Chaloupka and Warner, 2001). The most severe effects of ETS include estimated annual deaths of between 2,400 and 3,000 for lung cancer and between 30,000 and 60,000 for heart disease. Moreover, 39,000 low birth weight infants of women who smoke during pregnancy are hospitalized annually, and more than 2,000 of these low birth weight babies die (Chaloupka and Warner; Evans, Ringel, and Stech; Gravelle and Zimmerman; Manning; Keeler, and Newhouse et. al, 1989).

These effects for the most part do not include the adverse effects that non-smokers may incur at the work place. Rather, the effects of ETS are largely in the

family (Manning et al.; Keeler et al, 2001). As such, the Manning et al. study considers all costs from ETS as internal, as it is assumed that smokers generally take into account the well being of spouses and children when deciding to smoke. The same conscious behavior is assumed for smoking mothers and their unborn babies. Consequently, the effects that family members and unborn babies of smokers incur as internal costs, e.g. pain and premature death, are not subject to taxation. Nevertheless, in view of their magnitude, it may be questionable to exclude the entire ETS-linked costs from taxation even if only a small share is not internalized by smokers.

Considering only the three largest cost items underscores the relevance of an exact quantification of the ETS-linked taxable costs. The 2,000 lost lives of unborn babies translate to a lower bound of 46 cents per pack when inflated to 2003 dollars. Based on conservative death rates, the lung cancer deaths lead to costs of 21 cents per pack and the heart disease deaths add at least 81 cents per pack. (Chaloupka and Warner, 2001; Evans, Ringel, and Stech, 1999; Manning et al.; Keeler et al.). These value-of-life estimates are based on the “willingness-to-pay” approach, which estimates the price an individual is willing to pay for reducing his risk of premature death. Some of these ETS-linked costs incurred in the family, e.g. medical costs, are likely borne by publicly financed programs and the consideration of only a small fraction of those costs of \$1.48 as external would have an impact on the efficient tax rate.

Additional spillovers on publicly financed programs are generated from the medical treatment and later education of low birth weight babies with long-term developmental disabilities. In sum, these costs translate to 4 cents (Evans, Ringel, and Stech, 1999) per pack when inflated to 2003 dollars. More spillover effects are likely from the medical treatment of the 150,000 to 300,000 children who suffer from ETS-linked lower respiratory tract infections and the 200,000 to 1 million children who experience ETS-induced worsening of asthma (U.S. Department of Health and Human Services, 2000).

It is reasonable to presume that both adults and youth are now fully aware of the health risks of smoking. In fact, recent studies suggest that the health risks of smoking may even be overestimated. Teenagers attach a higher risk to smoking than the rest of the population and smokers do not underestimate the decline in life expectancy from smoking [Grossman, Sindelar, and Mullahy, 1993]. Hence, this study concludes smoking related risks are correctly perceived, i.e., there is no market failure in this regard and therefore it does not constitute a cost subject to appropriate taxation.

Summary of Taxable Costs based on the Rational Addiction Model

Our estimates of these taxable costs of smoking are provided in Table 1 for various discount rates. Results are very sensitive to changes in the discount rate especially for rates below 5% because the large savings of retirement

pension, disability compensation, and nursing home costs are at the end of the smoker's life. Our discussion centers on a discount rate of 5%, the rate frequently used in relevant studies (Chaloupka and Warner, 2001; U.S. Department of Health and Human Services, 2000).

Table 1. Per Pack Taxable Costs of Cigarettes.

Quantified Cost Component	Taxable Costs per Pack with Alternative Discount Rates		
	0%	5%	10%
Medical Costs	0.95	0.65	0.45
Retirement Pension and Disability	-2.69	-0.36	-0.03
Sick Leave	0.01	0.01	0.02
Group Life Insurance	0.16	0.07	0.03
Nursing Home	-0.65	-0.08	0.00
Taxes on Earnings	0.96	0.13	0.03
Property Damage from Fires	0.03	0.03	0.03
Total	-1.23	0.46	0.53
Other Costs			
Medical Treatment of Fire Burn Victims		No Estimate	
Environmental Tobacco Smoke (ETS)			
Low Birth Weight Babies			
Hospitalization and Special Education		Fraction of 0.04	
Death		Fraction of 0.46	
Children			
More Lower Respiratory Tract Infections		No Estimate	
Worsening of Asthma		No Estimate	
Adults			
Lung Cancer Deaths		Fraction of 0.21	
Heart Disease Deaths		Fraction of 0.81	
Total		Fraction of 1.52	

Note: Positive values are cost savings.

Translation of Taxable Costs into Efficient Cigarette Tax Rate

One way of determining the efficient tax rate per pack of cigarettes would be to calculate the taxable costs of smoking as a direct proportion of a uniform tax rate per pack of cigarettes. However, the relationship between the taxable costs of smoking and the efficient cigarette tax rate is influenced by several fairly complex determinants the two most important being the elasticity of the supply curve and the cigarette industry's market structure.

Smokers adjust their consumption according to the cigarette price. As such, the design of an optimal cigarette tax level based on economic efficiency grounds needs to adjust for price changes that markedly exceed the change in tax. For example, if the retail price rises by more than the tax increase, a tax rate designed to move consumption towards the Pareto-efficient level may reduce consumption below the intended level. The price response will be proportionate to the tax if supply is perfectly elastic, a condition which holds if cigarette manufacturing is a purely competitive constant-cost industry.

Analysis of the industry and its pricing behavior suggests that it is not purely competitive. The U.S. cigarette industry is clearly an oligopoly with at most six firms controlling virtually all output. Firms are seen as possessing some market power, primarily because brand loyalty creates a barrier to entry. Further, the tax-price relationship is different for federal cigarette tax increases than for state tax hikes. The difference in effect is attributed to federal tax increase announcements prior to the tax increase, which have been used by the cigarette industry as focal points for joint oligopolistic price increases. Federal cigarette tax increases of 1 cent have been found to lead to slightly more than 1 cent increases in retail price (U.S. Department Health and Human Services, 2000).

Cigarettes are taxed at a constant, uniform per pack rate. Ideally, the marginal tax rate reflects the marginal taxable cost of smoking. If the taxable costs of smoking are directly proportional to the amount smoked, the efficient tax rate per pack equals the constant marginal taxable cost for any consumed quantity. However, a linear consumption cost relationship might not hold for certain taxable costs. Medical costs, for example, are tightly linked to smoking related illnesses. Lung cancer is one of the main smoking related diseases, and epidemiological evidence suggests that lung cancer incidence increases with the square of the amount smoked daily and with the duration of smoking raised to the power of four to five (U.S. Department of Health and Human Services, 1989). These relations suggest that at least some of the costs of smoking do not increase in a linear fashion. As such, a uniform tax rate per pack of cigarettes will likely lead to the over-taxation of smokers who are light consumers and those who only smoke for a short period in their lives and to the under-taxation of heavy and life-long smokers.

As an approximation, the taxable costs of smoking are translated directly proportionately into the efficient excise tax rate and the taxable costs in Table 1 reflect the efficient tax rate per pack. Thus, based on the rational addiction model, the efficient cigarette excise tax rate is \$0.46 per pack plus a non-quantified fraction of \$1.52 per pack.

Calculating the Efficient Cigarette Tax Based on Time-Inconsistent Addictive Behavior

Estimates of the efficient cigarette tax rate based on the time-inconsistent addictive behavior approach are provided here. In addition to the costs considered under the rational addiction model, time-inconsistent smoking behavior justifies additional taxes to correct market failure due to addictive behavior.

The efficient tax level depends on whether addicts are rather sophisticated or naive, that is, the degree to which addicts are aware that they make time-inconsistent smoking decisions. The tax is higher for the naive because it serves as a self-control device and a way to correct the misperception problem concerning their future behavior. However, the sophisticated and the naive case represent extremes of how smokers perceive their addiction. Most addicts may possess elements of both. This study only presents the efficient tax rate for sophisticates as a lower bound. The tax rate for the naive is likely to be much higher.

Gruber and Koszegi take the smoker's long-run preferences as those relevant for social welfare maximization and assessment of the optimal tax rate. Taking the short-run preferences yields a lower tax. However, the difference in the long-run and short-run tax rates is small if b and d are sufficiently large, meaning smokers care about the future to a significant extent.

The efficient tax rate is calculated for maximizing a sophisticated hyperbolic smoker's utility. First, the internal costs smokers incur from smoking are valued by taking into account as the only disutility from smoking the increased chance of early death. This approach is conservative since non-mortality effects (disutilities from smoking during lifetime such as coughing and non-life threatening diseases) are excluded. The life of a worker is valued at \$6.4 million based on the willingness-to-pay approach. The resulting internal costs are calculated using a discount rate of 4% and the average reduction in smokers' life expectancy of 6.1 years. The internalities based on the value of life lost due to smoking are calculated as \$30.45 cents per pack of cigarettes.

The efficient tax rate is based on the assumption of an only mild self-control problem. The authors calculate a lower bound of \$1 per pack of cigarettes, translating to \$1.02 in 2003 dollars. The tax rate would be substantially higher if a markedly higher degree of time inconsistency actually

holds. Arriving at the lower bound of \$1.02 per pack, it could be argued that smokers with time-consistent preferences (i.e., “happy addicts”) are being overtaxed. Taking the share of 80% of smokers who wish to quit smoking as proxy for the share of time-inconsistent smokers, the lower bound for the efficient tax rate is reduced to \$0.82 per pack.ⁱⁱⁱ In sum, assumed that smoking behavior follows time-inconsistent preferences, the efficient cigarette excise tax rate per pack is \$0.46, an undetermined share of \$1.52 per pack, and at least \$0.82 per pack for the taxation of market failure due to addictive behavior.

Conclusions

Cigarette smoking causes market failures that prevent the efficient allocation of resources and the maximization of social welfare. The efficient cigarette excise tax rate depends on the approach taken towards viewing smoking decisions in the context of addictive behavior. The rational addiction model leads to an efficient tax rate of \$0.46 per pack plus a non-quantified share of \$1.52. As such, unless this undetermined share is large, the majority of the states have increased their cigarette excise tax rates to levels beyond the economically efficient point. Contrarily, assuming time-inconsistent addictive behavior, the efficient excise tax rate is estimated at \$1.28 per pack plus the share of \$1.52. If smokers have time-inconsistent preferences, combined federal and state tax rates well beyond \$1 can be justified.

We conclude that the time-inconsistent approach provides a more compelling picture of real-life cigarette smoking decisions. As previously stated, casual observation, introspection, and psychological research all suggest that the assumption of time-inconsistency is appropriate. Survey results indicating that 80% of smokers wish to quit but ultimately do not in particular provides evidence of time-inconsistent behavior. Further, young smokers, who often underestimate the addictive potential of cigarette smoking, have behavior that fits the concept of naïve, time-inconsistent consumers. As such, a combined cigarette excise tax of \$1.30 appears to be efficient with further increases justified based on possible external effects of second hand smoke. Further research in the field of efficient cigarette taxation should focus on quantifying this share, considering the potential effect that these costs may have on the efficient taxation of cigarettes.

This study also offers other interesting research possibilities. In particular, we have ignored the political economy of cigarette tax increases with our focus on the efficient tax rate. But decisions to increase taxes are made by governmental bodies comprised of individuals who may also be time-inconsistent. An interesting area of future work would be to examine how time-inconsistency may impact the decision to increase cigarette excise taxes in particular and governmental decisions in general. In particular, cigarette tax increases raise issues of a “moral majority” imposing its will on smokers. Motivations for tax increase also include the desire to raise tax revenues. An interesting area of research would be how to implement policies in current

political climates that will actually yield an approximation of the efficient tax rate, given the forces that are involved.^{iv}

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ⁱ Of course, in stating that social welfare is enhanced, an assumption is made regarding how much to weigh the welfare of losses versus the welfare of gainers or a social welfare function is determined by policy makers. Such assumptions require value judgments by those making the resource allocation decisions. Typically in cost-benefit analysis, the marginal loss in income and ultimately utility for losers is often assumed to carry equal weight in comparison to the marginal gain in income and ultimately utility for the winners. We wish to thank an anonymous reviewer for sharpening our thinking in this regard.

ⁱⁱ It has been suggested that some external costs arise from the medical treatment of burn victims by the publicly financed health care system (U.S. Department of Health and Human Services, 2000). But to our knowledge, no estimate of such costs exists.

ⁱⁱⁱ As an anonymous reviewer points out, arguable from a Coasian externality viewpoint these 20% are being overtaxed and this damage could be deducted from the efficient tax rate.

^{iv} Once again, we wish to thank an anonymous reviewer for these points.



<http://www.westga.edu/~bquest>