ELSEVIER

Journal of Health Economics 19 (2000) 421–437

JOURNAL OF HEALTH ECONOMICS

www.elsevier.nl/locate/econbase

Addiction as a market failure: using rational addiction results to justify tobacco regulation

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Received 2 July 1999; received in revised form 18 September 1999; accepted 30 November 1999

Abstract

Tobacco regulation efforts have been criticized by some academic economists for failing to provide adequate welfare-analytic justification. This paper attempts to address these criticisms. Unlike previous research that has discussed second-hand smoke and health care financing externalities, this paper develops the logic for identifying the much larger market failures attributable to the failure of smokers to fully internalize the costs of their addictive behavior. The focus is on teen addiction as a form of ''intrapersonal'' externality and observed adult consumption behavior consistent with partial myopia. The importance of peer effects, in the consideration of welfare impacts, is also emphasized.

JEL classification: I-18; D61; D62
Keywords: Rational addiction; Smoking; Tobacco regulation; Intrapersonal externality; Peer effects

1. Introduction

Most governments of developed nations, including those of the United States, Canada, France, Iceland, Finland, Norway, Portugal, Nine Eastern European countries, Sweden, Singapore, Italy, New Zealand, Australia, Japan, and South Africa, have initiated programs of tobacco control (Wyckham, 1997). These

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0167-6296/00/$ - see front matter
PII: S0167-6296(99)00040-5

programs typically involve excise taxes aimed at demand reduction, restrictions on advertising, label warnings, access restrictions, etc. Tobacco control is clearly an important, worldwide public policy mission. At the same time, however, there has been an active line of economic research arguing against most tobacco control efforts. These economic arguments, based on the principles of consumer sovereignty, assert that tobacco control initiatives are inefficient and reduce the public welfare. Notable authors in this literature are Viscusi (e.g., Viscusi, 1991, 1994) and Tollison and Wagner (e.g., Tollison and Wagner, 1988, 1992). How can this state of affairs be reconciled?

Traditional analyses of the benefits and costs of tobacco regulation have focused on two primary externalities: (1) financial externalities of added health care cost burdens that smokers may impose on nonsmokers, and (2) environmental externalities of impacts that passive smoking and accidental fires may impose on nonsmokers. Many commentators in the tobacco control debate, however, see these externalities as relatively small. Regarding the burden that smokers may impose on the public through excess public health care costs, see for example, the estimates of Manning et al. (1991) and the conceptual discussion of Warner et al. (1995). Regarding the externality of second-hand smoking, see for example, the reviews by EPA (1992) and Gravelle and Zimmerman (1994).

The focus of this paper is on a third form of market failure — one that provides an alternative approach for the welfare-analytics of tobacco regulation. Since it concerns the costs that smokers fail to internalize and subsequently impose on themselves, this market failure can be thought of as an intrapersonal or addiction externality. As emphasized by many authors (see, for example, Schelling, 1986), by far the largest societal costs of smoking are the costs that smoking imposes on smokers themselves. [1] The innovation of this paper is to illustrate how a substantial portion of these costs, amounts sufficient to explain the broad interest in regulatory interventions, can be argued to result from market failure.

To develop this logic, this paper uses three fundamental arguments. The first and most well known has to do with age of consent and the externality that juvenile smokers impose on their future adult selves. To the extent that we as a society do not accept the revealed preferences of children as being indicative of their welfare and we believe that those under the age of consent should not smoke, then we believe that youth smoking represents a market failure. Furthermore, and this is the focus of the argument, to the extent that this youth smoking is addictive, it influences adult behavior and imposes an intrapersonal externality on adult welfare.

The second and perhaps more innovative argument involves the possibility of adult irrationality in cigarette consumption. Although the structure of the modeling approach makes precise estimation difficult, empirical results from the rational

[1] See Manning et al. (1991, Chapter 4), for an estimation and comparison of these costs.

addiction literature cast considerable doubt over the fullness of adult rationality in cigarette consumption. This is because, although these empirics do show adult smokers to be somewhat forward looking, the strength of this behavior is relatively weak and is not sufficient to be consistent with full rationality. If these empirical results were accepted, the welfare impacts associated with the estimated failure in rationality would be substantial.

The third argument relates to the treatment of peer effects. Whereas the previous literature measures the excess burden of tobacco taxation using aggregate demand curves, welfare considerations to account for the endogeneity of preferences for goods that exhibit strong peer effects require more subtle analysis. Indeed, it is shown that because of these peer effects the welfare analytics of tobacco taxation become indeterminant and can lead to interpretations of the excess burdens from cigarette taxation that are actually negative.[2] Finally, the analysis concludes with brief suggestions for future empirical research strategies that could improve our understanding of these addiction-externality market failures.

2. The addiction externality of youth smoking

The 1996 U.S. Food and Drug Administration (FDA) anti-tobacco initiative was crafted specifically to combat youth smoking. This strategy made sense for several reasons. First, a casual review of U.S. data reveals that many of today's current adult smokers started smoking when they were below the age of consent. In a 1991 survey of adult ever-smokers aged 30 through 39, 82% reported having first tried a cigarette and 53% reported having begun daily smoking at or before the age of 18. Using 20 as an age of consent, 77% started smoking daily while they were still in their teens.[3] Since the 1980s, almost no regular smoking was begun by individuals after the age of 20.[4] Second, although public sentiment may be mixed regarding the proper role of the government in regulating or discouraging adult smoking, public opinion is almost universally opposed to youth smoking.

These points lead to the first argument in favor of the consumer benefits of tobacco regulation — that tobacco regulation can be justified as correcting an

[2] This is a two-edged sword that, from the perspective of the existing debate and because of the geometry involved, seems to cut more sharply when used in favor of tobacco regulation than against it.

[3] See Centers for Disease Control (1994, Chapter 3, p. 65). Clearly, if all the smokers who started before age 20 had been prevented from smoking until they reached majority, some may still have decided to smoke. As will be shown below, however, rational addiction analysis provides evidence that many fewer of these individuals would have started smoking.

[4] See Food and Drug Administration (1995). This may, however, be changing. Recent results of a nationwide survey of college students show an estimated 27.8% rise in smoking initiation rates among U.S. college students, mostly above the age of 18 (Wechsler et al., 1988).

externality that youth smokers impose on their future adult selves. Some statistical support for rejecting the tenets of consumer sovereignty with respect to children is provided by Chaloupka (1991), who found considerable myopia among young smokers in his empirical analysis of rational addiction. More generally, there are a broad range of policies in the U.S. (and around the world) designed to protect children and restrict their freedom of choice. Children are not allowed to enter into debt contracts (without parental participation, until age 18), they are restricted from purchasing alcohol (until age 21, in almost all U.S. states), and, until some minimum age that varies by state, they are required to attend some socially approved form of education. These policies indicate a broad social consensus against interpreting the revealed preferences of children as fully indicative of their personal welfare. The societal convention therefore is that parents, and to some extent governments (through regulation, schools, and the courts), remain somewhat responsible for guiding the consumption decisions of children. In effect, the current policy consensus is that child welfare is de facto measured largely by the laws and preferences of adults.[5]

To justify its 1996 tobacco rule, the FDA contended that underage smoking, due to the persistent effects of youth addiction on adult utility, creates an externality-induced market failure. The agency argued that eliminating these addictions would sharply reduce the adult demand for cigarettes. Fig. 1 illustrates the structure of this argument. It plots hypothetical adult demand curves for cigarettes against a flat supply or marginal cost curve for cigarettes. This marginal cost curve represents a summation of cigarette purchase price, adverse health consequences, and incremental addiction effects. By the standard analysis, the welfare maximizing quantity of trade in cigarettes would occur at the quantity where demand equals supply, q_0. If, however, teen consumption were eliminated and the addiction externality were removed, then adult demand would shift substantially to the left (to D_2).

Demand curve, D_1, represents the state of the world after some regulatory intervention to reduce teen smoking. Since regulatory intervention will be costly and no intervention is likely to be completely effective in eliminating youth smoking, this curve is between D_0 and D_2. The net benefit of the regulation as measured on this chart is the darkly shaded area. This is the total savings in adverse health consequences, addiction effects, and purchase costs for new nonsmokers (total shaded area) less their opportunity cost of forgone smoking satisfaction (more lightly shaded area under demand curve D_1). A cost-effectiveness assessment, to determine the optimal location of curve D_1, would need to

[5] Clearly, one could construct primitives for the welfare functions of children that would give some weight to their preferences for cigarettes. The question is, how would these weights be decided? Since such considerations reflect questions of degree and would not alter the fundamental argument of this section, I simply assume that ''kids should not smoke'' and give zero weight to these preferences for cigarettes.

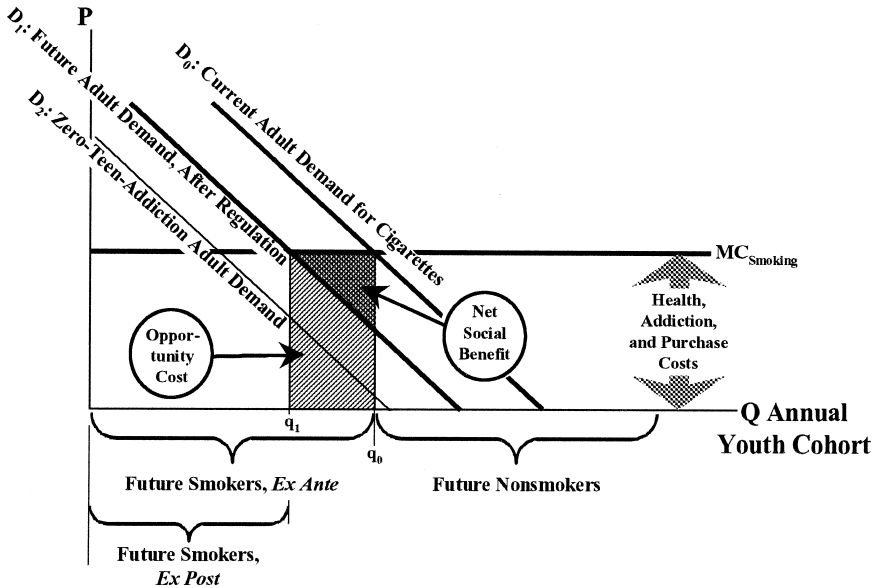

Fig. 1. Youth addiction as an externality.

compare these net benefits against implementation costs, worker dislocation, and impacts on industry.

What is the evidence of this externality? The dominant framework that has been used for the econometric estimation of addiction effects, in recent years, is the rational addiction model of Becker and Murphy (1988). This framework models addictive behavior as being perfectly rational. Consumers anticipate the addiction and health consequences of their decisions and choose to adopt addictive behavior because the anticipated benefits from this consumption, in terms of smoking pleasure, peer acceptance, etc., out-weigh all of these costs. Rational addiction also assumes that preferences are stable for the individual, throughout her lifetime. The effects of addiction on preferences are carried forward from period to period by the incorporation of a variable for addictive stock (depreciated past consumption) into the consumer's utility function.

As developed in this theory, addictive goods exhibit intertemporal complementarities in consumption — in the presence of addiction, short-term price elasticities will, for example, be smaller than long-term elasticities. Thus, if a consumer is rational in deciding whether or not to consume and how much to consume of a product that is addictive, the consumer should optimize over an expected lifetime consumption path. As expressed by Becker and Murphy, at any given point in time, τ, the consumer maximizes the value of

$$U(\tau) = \int_{\tau}^{T} e^{-\sigma t} u[v(t), c(t), S(t)]\,dt \qquad (1)$$

where $T-\tau$ is the expected remaining length of life, $u()$ is a stable, intertemporally separable utility function, $y(t)$ is the time t consumption of other goods, $c(t)$ is the time t consumption of the addictive good, $S(t)$ is the time t addictive stock, and σ is a discount rate. Intertemporal complementarities, in this framework, imply that $u_{cS}>0$. For a harmful addictive, like cigarettes, the consumer's utility decreases with the level of his addictive stock, $u_S<0$.[6]

For estimation, this model is converted to discrete time and, assuming the consumer is optimizing from near the stable steady state level of addictive stock, yields a second-order difference equation that is applied to the data.

$$C(t)=\theta C_{t-1}+\beta\theta C_{t+1}+\theta_1 P_t+\text{fixed effects, etc.} \tag{2}$$

where θ and $\beta\theta$ estimate the influence of exogenous past and future consumption shocks on current consumption and β is an implied discount factor.[7] Addiction effects are measured by estimates of the roots of the above second-order difference equation. The reciprocal of the larger of these roots measures the impact of an exogenous shock to past consumption on current consumption and thus represents the addiction effect.[8]

Empirical studies using this framework[9] support the view that cigarette consumption is substantially influenced by addiction. Since he uses individual-level rather than aggregate data, this paper focuses on Chaloupka (1991) results. By the least restrictive of his estimation equations Chaloupka finds that, at the mean, between 62% (both full sample and ever-smokers subsample) and 95% (subsample of current smokers only) of a given year's smoking can be attributed to addiction

[6] Because $u_{cS}>0$, adult demand shifts to the left as youth consumption is reduced. Because $u_S<0$, the externality of youth smoking is negative. By this $u_S<0$ property, the full adult benefit from reduced smoking is $\mathscr{U}(\tau)=\int_{\tau=18}^{T}e^{-\sigma t}(u[y(t),c(t),S'(t)]-u[y(t),c(t),S(t)])dt$, where $S'(t)$ describes the post-intervention path of addictive stock and $S(t)$ describes the pre-intervention path. This benefit includes: (1) the gains to future smokers from starting at a lower base level of addictive stock, i.e., they will have less addictive cravings to satisfy and will be able to smoke more for pleasure; and (2) the gain to would-be smokers from starting their adulthood with a low enough level of addictive stock so that they choose not to become or remain smokers. It is this second effect that is depicted in Fig. 1. An emphasis on this effect is consistent with a policy goal of reducing smoking participation as opposed to increasing adult smoking satisfaction. It is also consistent with the convention that welfare benefits should be measured as they are derived from the *consequences* of changes in choice, as opposed to shifts in preferences.

[7] Whereas adjustment costs experienced from having lower current consumption than past consumption must be paid now, the adjustment costs experienced from not adjusting current consumption to match anticipated future consumption will not be paid until next period. Thus the implied discount factor.

[8] Because the estimate of this root, $\lambda_2=[1+(1-4\theta^2\beta)^{0.5}]/2\theta$, is the result of a *nonlinear* combination of random variables, it will be estimated with some small bias.

[9] Widely cited tests of the rational addiction model using data on cigarette consumption have been done by Becker et al. (1994), Chaloupka (1991) and Labeaga (1993).

Table 1
Chaloupka (1991), rational addiction estimates[a]

	Current smokers ($n = 5111$)	Ever smokers ($n = 7946$)	Full sample ($n = 14{,}305$)
Lagged consumption (year $t-1$)	0.657 (3.83)	0.494 (3.18)	0.516 (3.32)
Future consumption (year $t+1$)	0.324 (1.65)	0.331 (1.50)	0.268 (1.19)
Estimated addiction effect	0.948	0.622	0.618
Estimated forward looking effect	0.468	0.415	0.321

[a]Extracted from Chaloupka (1991), Tables 1A, B, and C. Reported asymptotic *t*-statistics are in parentheses.

effects (last year's smoking).[10] Note that this evidence is observed even from within the rational addiction framework that assumes, everything else being equal and excluding addiction effects, an individual who likes cigarettes today will continue to have the same preference for cigarettes tomorrow (Table 1).

To illustrate the magnitude of the shift in adult demand that could be realized by eliminating youth smoking, suppose 60% of this year's smoking behavior can be attributed to last year's smoking. Then, assuming consumption patterns are stable (that we can convert cigarettes smoked into years of smoking) 1.5 years of adult smoking can be attributed to each 17-year-old teen smoker.[11] If 95% of this year's smoking can be attributed to last year's smoking, then 19 years of adult smoking can be attributed to the addiction effects of a teen who has become a regular smoker of cigarettes by his 18th birthday. Comparing these numbers to the average adult duration of the smoking habit would show a substantial shift in adult demand and welfare benefit.

3. Evidence for myopia and addiction externalities in adult consumption

Although society at large has little difficulty accepting the notion that children tend to be myopic and has generally favored intervention to reduce youth cigarette consumption, there is much less agreement in attitudes toward intervention

[10] Given the wide range (62–95%) of Chaloupka's estimates, it would be preferable if one could select a single best measure. Unfortunately, as will be further discussed in Section 5, because of the statistical methods employed, this is not possible.

[11] An exogenous shock that reduced 17-year-old smoking by one cigarette would, through addiction effects, reduce adult smoking by 1.5 cigarettes. A formal estimation of this effect would also need to account for the typically lower levels of teenage consumption.

designed to influence adult behavior. By the principle of consumer sovereignty, economists have tended to be particularly uncomfortable with the idea of such interventions. Regardless of this, however, results from the rational addiction literature suggest we may be seeing substantial failures of rationality, and thus market failure, in adult cigarette consumption. Although available data and the structure of the rational addiction model has not allowed estimation of these failures of rationality with a high level of precision, this section illustrates how existing results, if accepted, identify a large intrapersonal externality, not only in youth smoking, but also in adult cigarette consumption. The focus of the discussion will be on Chaloupka (1991) and Becker et al. (1994) (hereafter denoted BGM).

The logic is as follows. If one assumes that consumers are rational and have stable preferences, then the discount rates they reveal in their consumption of addictives should approximate the discount rates they reveal by their savings and investment decisions. Because the consumption of addictives requires an optimal path, a divergence in these discount rates indicates time inconsistency and suboptimization. The rejection of a null hypothesis that discount rates revealed in addictives consumption equate to discounting over the consumption of other goods is therefore evidence of either unstable preferences or of bounded rationality. In either case, such results provide evidence of market failure (if consumers do not optimize, markets will not allocate goods efficiently). Table 2 shows results for various Chaloupka and BGM estimates.

Point estimates for the discount factors implied by these results for the Chaloupka estimates are $\beta = 0.242$, 0.337, and 1.07, for the 17–24-, 25–64-, and 65–74-year-old age groups, respectively. The implied discount factor for BGM results is 0.474. Clearly, an interpretation of these estimates as representing fully rational, forward-looking behavior is questionable. Can one use these estimates to reject the hypothesis of perfect consumer rationality?

Table 2
Rational addiction estimates of addiction and rationality

	17–24-year-olds ($n = 2575$)	25–64-year-olds ($n = 8997$)	65–73-year-olds ($n = 2733$)	Chaloupka average ($n = 14{,}305$)	BGM (1994) (state-level)
Lagged consumption (year $t-1$)	0.570 (3.13)	0.566 (2.93)	0.427 (4.10)	0.516 (3.32)	0.481 (14.58)
Future consumption (year $t+1$)	0.138 (0.56)	0.191 (0.77)	0.457 (3.57)	0.268 (1.19)	0.228 (5.87)
Estimated addiction effect	0.624	0.646	0.582	0.618	0.550
Estimated forward looking effect	0.151	0.218	0.622	0.321	0.261

To address this issue, BGM include tests that were run on a constrained model.[12] For the estimation procedure that is cited in Table 2, a restriction that set the implied discount factor, β, equal to 0.75 was significant at a 95% level of confidence (seemingly clear evidence of irrationality). For another of their estimation procedures (which included a more restricted set of instruments), they were, however, unable to show significance for such a constraint.[13] Based on these results, BGM conclude that richer data sets will be required to more reliably pin down these implied discount factors and advise caution in the interpretation of these difficult estimations. Given more recent results from empirical analyses of alcohol and cocaine addiction, it seems this caution was well advised. Grossman et al. (1998), using monitoring the future panel data on youth alcohol consumption find implied discount factors (β's) greater than one. Grossman and Chaloupka (1998) find similar results, with effective discount factors of approximately 1, for youth cocaine consumption.

Thus, the above discount factor estimates are clearly not solid. Nevertheless, they do provide substantial reason for doubt regarding the rationality of adult cigarette consumption. The next question thus becomes, assuming we had better data and that this data would allow us to unequivocally reject the hypothesis of rationality in adult cigarette consumption, how could we measure the extent of this irrationality? Once rationality is rejected, what becomes the appropriate null hypothesis and estimation approach? Can we use the rational addiction framework to support market failure measurements, without assuming rationality? This depends on the nature of adult smoking irrationality.

The best-known alternative theories of behavior in the consumption of addictives are those associated with the self-control literature (for example, see Schelling, 1984; Akerlof, 1991). Although the range of behaviors consistent with these theories would be quite large, some myopia in the consumption of addictives would certainly be consistent with them.[14] Another theory of behavior applicable to the consumption of addictives and largely amenable, in reduced form, to estimation in a rational addiction framework is that of melioration (surveyed by Herrnstein and Prelec, 1991). Models of behavior that would, in their reduced forms, be inconsistent with the rational addiction framework would be those that incorporate learning, such as the model of Orphanides and Zervos (1995).

In sum, for the majority of the alternative behavioral models of addiction, i.e., for those that predict some level of myopia or difficulty in self-control, the rational addiction model provides a reasonable reduced-form framework for estimation. An advantage of using this framework is that it is consistent with the norms of policy

[12] The Chaloupka paper does not perform such tests.

[13] Other estimation procedures yielding lower (more myopic) values of β were not tested. For more details and discussion, see Becker et al. (1994, pp. 411–412).

[14] The authors in this literature use myopia in the consumption of addictives as a motivating example.

analysis. Policy conclusions based on structural models that are inconsistent with rationality will be hard to sell. To the extent that modern policy analysis bases cost-benefit assessment on the principles of consumer sovereignty, it seems that the advice of Stigler and Becker (1977) that assumptions of consumer rationality and stationary preferences provide a practical framework for analysis is well taken.[15]

So, given that one could use the rational addiction framework for estimation of the magnitude of adult failure to internalize the full personal costs of their smoking behavior, this section concludes with a brief exploration of what this kind of adult consumption externality might imply in terms of welfare effects. Using an approximate average of the results of Chaloupka and BGM, we can say that, in their cigarette consumption decisions, adult smokers, at the mean estimate, exhibit instantaneous discount rates of approximately 90% per year. Similarly, taking an approximate average of the addiction effects across these two studies shows that slightly over 60% of present-year smoking is attributable to the previous year's smoking behavior.[16] Evaluating the resulting geometric series implies that, at the mean, for every cigarette smoked this year, an adult can expect to smoke 1.5 additional future cigarettes, through addiction effects.[17] This implies that, if the cost of other consumption is discounted at a 7% rate, current adult smokers are underestimating the effective costs of their cigarettes by approximately 40%.[18] Put differently, the adult addiction externality may be huge.[19] Although this paper does not intend to explore or recommend policy responses, to gauge the magnitude of

[15] Some might object that the extremely high discounting observed in adult smoking behavior results from changes in household production functions (Stigler and Becker, 1977). The problem with this criticism is that high discount rates are observed not only for young adults but also for 25- to 64-year-olds. Thus, the observed consumption patterns seem to represent dominant, not aberrant or episodic, behavior.

[16] As discussed previously, Chaloupka's estimates for the current-smoker sample show much higher addiction factors.

[17] Note that, as long as the level of smoking attributable to current-year building of addictive stock, as opposed to addictive consumption attributable to last year's stock, does not stay constant (and smokers exert effort to try to control their smoking level), this attribution of 1.5 future cigarettes to each current cigarette does not imply an increasing year-by-year level of smoking behavior.

[18] Assuming a 60% year-to-year addiction effect (50% instantaneous depreciation rate), 90% discounting for addictive purchases, and a discount factor for nonaddictive purchases of k%, the formula is $1-[(1+\int_0^\infty e^{-(0.5+0.9)t}dt)/(1+\int_0^\infty e^{-(0.5+k)t}dt)]$. Letting $k=7\%$, this implies that costs are underestimated by approximately 38%. The 7% baseline discount rate is hypothetical and is used only so that a specific number, rather than formula, can be provided to quantify the extent of underestimation. The appeal of this 7% number is that it is the standard hypothetical number used by the U.S. Office of Management and Budget (1996) for discounting costs and benefits to consumers in regulatory impact analyses.

[19] Clearly, this simple calculation is approximate. Careful analysis would need to account for the nonlinear combination of various estimation coefficients that are used in this estimation and other factors such as the appropriateness of using mean effects. Suggestions for future research with a focus on econometric issues are provided in Section 5.

this externality, a Pigovian tax appropriate to internalize this externality would amount to approximately $3 per pack. This assumes a tax-free (and litigation-free) price of cigarettes equal to $1 a pack and a very conservative estimate of the direct adverse health effects (exclusive of addiction effects) from smoking equal to $2 per pack.[20] Of course, an optimal policy would likely involve a mix of taxation and other regulatory responses.

4. Peer effects

Why is the smoking participation rate lower for African–American teens than for white teens? Why do those Indian women who can afford cigarettes have very low smoking participation rates, whereas those Indian men who can afford cigarettes have very high participation rates? Why has smoking participation recently become so closely associated with socioeconomic class in the U.S.? Many explanations are available but, in addition to various influences of social approval or disapprobation, it seems one important influence on our smoking behavior is the extent to which we have peers who smoke.

Peer group effects have long been an important consideration in the literature on tobacco regulation. What has been overlooked, however, are the important implications these peer group effects have for tobacco regulation welfare analysis. To see this, consider the following simple demand equation for cigarettes.

$$q_i = b_0 + b_1 p + b_2 q_{-i} + \beta \boldsymbol{X} + \varepsilon_i \tag{3}$$

where q_i is quantity demanded for individual i, p is current price, q_{-i} is quantity demanded for the average other person (peers), and $\boldsymbol{X}$ is a vector of other conditioning variables. By this equation, expected price elasticity of demand for individual i can be calculated as $b_1 p/q_i$. Measured market demand for an anonymous individual will, however, be based on the equation $q_i = (b_0 + b_1 p + \beta \boldsymbol{X} + \varepsilon_i)/(1 - b_2)$ yielding a reported elasticity of $b_1 p/q_i(1 - b_2)$.

Consider Fig. 2. In this figure, MC_0 represents a pre-intervention fixed marginal cost of smoking. This includes purchase price, health effects, addiction effects, and taxes. MC_1 includes these costs plus an additional cigarette tax. $Demand_{Soc}$ plots a social demand curve that reflects aggregate responses to changes in cigarette prices and is what an economist who uses aggregate data and

[20] At these prices, smokers would internalize costs of approximately $5 per pack while actual costs would be about $8 per pack. Manning et al. (1991, pp. 81–84) estimate the total financial costs of smoking (medical expenditures, lost productivity due to illness and early death, and the costs of fires) at 1.48 per pack (in 1986 dollars) over the tax-free purchase price of $1 per pack. They further discuss that accounting for smokers' willingness to pay to avoid early death would increase this number by perhaps $5 per pack (to a total of $6.48 in 1986 dollars). Thus, my use of a $1 per pack purchase price and $2 per pack health cost estimate are, in 1999 dollars, very conservative.

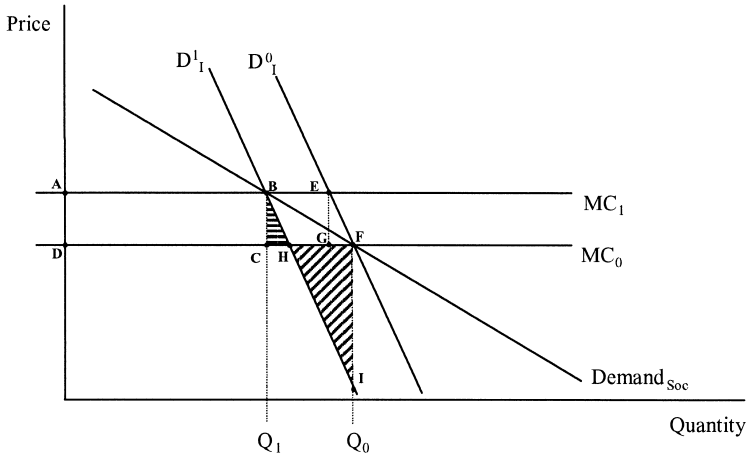

Fig. 2.

fails to control for peer effects would measure. D_I^0 and D_I^1 plot the sum of the individual demand curves, which reflect the demand for cigarettes that would be measured if the smoking behavior of others were held constant.

In this diagram, area BFC shows the excess burden of a tobacco tax as it would be measured using an aggregate social demand curve. Area EFG shows the excess burden of a tobacco tax as it would be measured using the sum of individual demand curves and assuming no shift in population consumption of tobacco. Area BHC shows this equivalent excess burden as measured for the lower, ex post level of social demand. As measured from the ex post perspective of lower societal demand (Q_1) a consumption shift from Q_0 to Q_1, brought about by a tax increase yields a net social benefit, equal to the shaded area, of HFI–BHC. Tax revenues ABCD represent a social transfer.

This example demonstrates that it is incorrect to assume that social losses necessarily result from the regulation of adult smoking activities. Indeed, Fig. 2 shows that the social welfare consequences of regulating a product that exhibits large peer group effects can not be identified from observed demand curves. To the extent that individual utilities are interdependent, there is no clear basis for determining the societal smoking rate that maximizes individual welfare.[21] Considerations of these sorts of consumer behavior effects are not new to economics

[21] Taking the analysis to the more fundamental level of utility functions, one could model the externality of peer influences on revealed preferences in terms of complementarities. This does not, however, resolve the question of what the optimal level of societal participation in smoking might be. If I assume peer smoking complements my smoking, the externality would be positive. If, however, I assume peer smoking reduces my preference for health and longevity, then the externality would be negative.

and were popularized by Liebenstein (1950). These considerations have not, however, been taken into account in the tobacco debate. Nor, to my knowledge, has a general policy for how to handle the resulting ambiguity for welfare analysis been determined.[22]

Empirical research on peer effects in smoking has focused mostly on teen behavior. Although these effects have been discussed and even emphasized in many papers,[23] there are few sources of good estimations. The empirical analysis most focused on this issue that I am aware of is a paper by J. Howard Beales, III (Beales, 1996). Beales' study deals exclusively on teenagers, ages 12–18, and relies on data from a 1989 Centers for Disease Control survey, ''Teenage Attitudes and Practices Survey'' (TAPS).[24] Using logistical regression techniques to predict the likelihood, across various peer-influence proxies, of a given teen being a never-smoker, a daily smoker, or one of two intermediate categories, Beales' analysis predicts that peer effects have an enormous impact on the likelihood of teen smoking.[25] A switch from a baseline case with all explanatory variables at their mean values to predicted results for an otherwise equivalent teen who gives pro-smoking responses to peer-influence questions yields more than a 20-fold increase in the predicted likelihood of being a daily smoker.

Note also that the youth and adult addiction externalities, discussed in Sections 2 and 3, tend to be amplified by these peer effects. To the extent that my rational smoking will increase my peers' preferences for smoking, that portion of my smoking attributable to my failures in self-control will also influence the smoking behavior of others. A full assessment of addiction externalities would thus need to account for these peer effects.

To what extent are these peer effects also influential for adult consumption? Some results for the influence of household members on adult smoking behavior, as opposed to peer effects, are available from Yen and Jones (1996). They find that smoking by a household member increases the likelihood of adult participation. Perhaps, surprisingly, however, they also find that, although adult participation rates increase, cigarette consumption levels given this participation actually decrease. As they explain, this second result is likely attributable to a sample bias;

[22] U.S. Government guidance for the conduct of regulatory impact analyses is provided in Office of Management and Budget (1996).

[23] See, for example, Lewit et al. (1981).

[24] As reported in Beales' study, the TAPS survey provided 9965 teen observations of which 923 had to be eliminated because of missing data. The Beales study also used a survey of 5040 California teens that paralleled the TAPS survey. He used this survey primarily to explore advertising issues and to perform the pretest of model specification for the larger TAPS survey analysis (thus, avoiding pretest bias in his primary results). Two percent of TAPS respondents were 11- or 19-year-olds.

[25] One difficulty with Beales' estimates is that they include some endogeneity. If teenager i influences teenager j, then the reverse will also be true. Although this endogeneity problem will cause Beales' results to be somewhat exaggerated, his study still points to enormous peer effects in teen smoking.

many would-be nonsmokers may instead, because they share a house with a smoker, be light smokers.

5. Suggested directions for future research

A problem with both the Chaloupka (1991) and Becker et al. (1994) results is that their estimation approach is not entirely consistent with the underlying rational addiction model.[26] The theory behind these estimates assumes that consumers are at near-optimal interior (positive consumption) points on their cigarette consumption paths. Thus, this theory is inconsistent with data samples that include large numbers of nonsmokers and quitters. As pointed out by Jones (1994, 1999), an alternative estimation approach would use a double-hurdle model. This is a method that jointly estimates first a probability of smoking or quitting and then, secondly, a level of cigarette consumption conditioned on the likelihood that the individual remains a smoker. The implication of this critique for Chaloupka's estimates is to put more weight on estimates derived from his restricted sample of current smokers. The problem here, however, is that these restricted sample estimates suffer from sample bias — estimates from a sample of smokers who are known, ex post, to have continued smoking will overestimate the effects of addiction.

Better longitudinal data combined with this double-hurdle modeling approach may substantially improve the precision with which implied discount factors can be estimated. Presumably, this research would also benefit from further empirical study of what the structural foundations may be for failures of rationality in addictives consumption. Can these failures be estimated in a rational addiction framework? This paper suggests that research along these lines may help identify large market failures in addictives consumption.

Finally, for any policy analysis of addiction, it is not necessarily desirable to use estimates that are based on mean effects. Presumably, some subset of smokers, perhaps those with poor self-image or particularly strong self-control problems, will be more susceptible to addiction than others. These individuals will suffer disproportionately from any addiction effects. Measures of addiction based on mean effects may thus misrepresent actual social costs of addiction. Quantile regression techniques would thus also be desirable.

[26] Another difficulty with using the Chaloupka's estimates is that the data available for his estimates provides only two reported smoking levels for a model that requires three smoking-level observations. To overcome this difficulty, Chaloupka uses a reported prior maximum level of cigarette smoking to serve as his first smoking-level data point. This will impose some, most likely downward, bias on his estimates of addiction effects.

6. Conclusion

As emphasized by Shelling (1986), it is the costs that smoking behavior imposes on smokers themselves that are by far the largest social costs of smoking. This paper has developed logic for identifying intrapersonal externalities in cigarette consumption that can be used to attribute a substantial portion of these costs to market failure. In doing so, this paper addresses what seem to be the fundamental arguments for why we have tobacco control policies.[27]

The first of these arguments concerns youth smoking. To the extent that we as a society do not accept the revealed preferences of teenagers as indicative of their welfare (and we believe that teenagers should not smoke), then youth smoking represents a market failure. Furthermore, addiction effect estimates can be used to estimate the impact of this market failure on adult utility. Using this logic, rough calculations indicate that between 1.5 and 19 years of adult smoking can be attributed to each case of teen addiction.

The second argument concerns adult smoking. This shows that results from empirical applications of the rational addiction model cast doubt over the completeness of rationality in adult cigarette consumption. If adult smoking is irrational, can we use a rational addiction framework to estimate the magnitude of this irrationality (and resulting market failure)? The argument is that, to the extent this irrationality can be treated as a relatively stable myopia (or inability of addicts to properly internalize the future costs in their consumption decisions), the reduced form estimation procedure from the rational addiction framework is structurally appropriate. The desirability of using the rational addiction framework is strengthened by the consideration that this framework does not impose a structure of presumed irrationality on the estimation. Given current norms in policy analysis, this is an important consideration. Given that this logic is accepted, an interpretation of mean-effects results from existing studies that use the rational addiction framework supports estimates that, through myopia, adult smokers underestimate the present and future costs of their smoking behavior by 40%. When conservative estimates of health costs are included in the calculation of costs of smoking, this argues for potential Pigovian tax remedies of up to $3 per pack of cigarettes. Clearly, optimal policy would involve some mix of taxation and other regulatory responses. Concerns regarding the available precision of these rational addiction estimates require that these results be interpreted with caution. Still, this could be a very fruitful topic for future research.

The third argument points out another consideration that has been neglected in the tobacco regulation cost-benefit debate — the importance of peer effects. For a good that exhibits consumption peer effects, aggregate-level demand estimates will

[27] Questions regarding cost-effective strategies for implementation of any regulatory initiative are not addressed in this paper.

mismeasure individual-level price responsiveness. Because of this, such estimates will also mismeasure the excess burden of excise tax policy. Indeed, for the consumption of goods that exhibit strong peer effects, such consumer welfare analysis is indeterminant. The measurement of social costs and benefits depends on a presupposed desirable social level of smoking behavior. Finally, it should be noted that peer effects in smoking behavior would tend to magnify the costs of market failures described in the first two arguments.

In terms of implications for future research, this paper has emphasized a different perspective for the analysis of the welfare impacts of addictive behavior. Whereas previous research has tended to focus on standard inter-personal externalities, this paper identifies intrapersonal externalities as a primary source of market failure in tobacco consumption. This logic may also be helpful for policy analysis regarding other addictive behaviors, such as gambling, alcohol consumption, and illegal drug use.

Acknowledgements

Although the author did previously work for the United States Food and Drug Administration on the economic analysis for its tobacco regulation initiative, this current work was neither funded nor approved by the FDA and is not intended to reflect any FDA position. Special thanks go to Larry Braslow for the exceptional generosity he has shown in discussing this project and in reviewing early drafts of this paper. Thanks also go to John Lienesch, of the FDA, Michael Grossman, and seminar participants at the CIDE and the ITAM, in Mexico City, for helpful advice and comments.

References

Akerlof, G.A., 1991. Procrastination and obedience. American Economic Review 81, 1–19.

Beales, J.H., III, 1996. The determinants of teenage smoking behavior. George Washington University, School of Business and Public Management working paper number 96-34.

Becker, G.S., Grossman, M., Murphy, K.M., 1994. An empirical analysis of cigarette addiction. American Economic Review 84, 396–418.

Becker, G.S., Murphy, K.M., 1988. A theory of rational addiction. Journal of Political Economy 96, 675–700.

Centers for Disease Control, 1994, Preventing tobacco use among young people: a report of the Surgeon General, U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Center for Chronic Disease Prevention and Health Promotion, Office on Smoking and Health.

Chaloupka, F.J., 1991. Rational addictive behavior and cigarette smoking. Journal of Political Economy 99, 722–742.

Environmental Protection Agency, 1992. Respiratory Health Effects of Passive Smoking: Lung and Other Cancer Disorders. United States Environmental Protection Agency.

Food and Drug Administration, 1995. Regulations restricting the sale and distribution of cigarettes and smokeless tobacco products to protect children and adolescents: Section VIII. Analysis of impacts. Federal Register of the United States 60, 41359–41372.

Gravelle, J.G., Zimmerman, D., 1994. Cigarette taxes to finance health care reform: an economic analysis. Congressional Research Service report 94-214E.

Grossman, M., Chaloupka, F.J., 1998. The demand for cocaine by young adults: a rational addiction approach. Journal of Health Economics 17, 427–474.

Grossman, M., Chaloupka, F.J., Sirtalan, I., 1998. An empirical analysis of alcohol addiction: results from the monitoring the future panels. Economic Inquiry 36, 39–48.

Herrnstein, R.J., Prelec, D., 1991. Melioration — a theory of distributed choice. Journal of Economic Perspectives 5, 137–156.

Jones, A.M., 1994. Health, addiction, social interaction and the decision to quit smoking. Journal of Health Economics 13, 93–110.

Jones, A.M., 1999. Adjustment costs, withdrawal effects, and cigarette addiction. Journal of Health Economics 18, 125–137.

Labeaga, J.M., 1993. Individual behavior and tobacco consumption: a panel data approach. Health Economics 2, 103–112.

Lewit, E.M., Coate, D., Grossman, M., 1981. The effects of government regulation on teenage smoking. Journal of Law and Economics 24, 545–569.

Liebenstein, H., 1950. Bandwagon, snob, and Veblen effects in the theory of consumer demand. Quarterly Journal of Economics 64, 183–207.

Manning, W.G., Keeler, E.B., Newhouse, J.P., Sloss, E.M., Wasserman, J., 1991. The Costs of Poor Health Habits. Harvard Univ. Press, Cambridge.

Office of Management and Budget, 1996. Economic analysis of federal regulations under Executive Order 12866, United States Executive Office of the President, Office of Management and Budget.

Orphanides, A., Zervos, D., 1995. Rational addiction with learning and regret. Journal of Political Economy 103, 739–758.

Schelling, T.C., 1984. Choice and Consequence. Harvard Univ. Press, Cambridge.

Schelling, T.C., 1986. Economics and cigarettes. Preventive Medicine 15, 549–560.

Stigler, G.J., Becker, G.S., 1977. De gustibus non est disputandum. American Economic Review 67, 76–90.

Tollison, R.D., Wagner, R.E., 1988. Smoking and the State: Social Costs, Rent Seeking, and Public Policy. Lexington Books, Lexington, MA.

Tollison, R.D., Wagner, R.E., 1992. The Economics of Smoking. Kluwer Academic Publishing, Norwell, MA.

Viscusi, W.K., 1991. Age variation in risk perceptions and smoking decisions. Review of Economics and Statistics 73, 577–588.

Viscusi, W.K., 1994. Promoting smokers' welfare with responsible taxation. National Tax Journal 47, 547–558.

Warner, K.E., Chaloupka, F.J., Cook, P.J., Manning, W.G., Newhouse, J.P., Novotny, T.E., Schelling, T.C., Townsend, J., 1995. Criteria for determining an optimal cigarette tax: the economist's perspective. Tobacco Control 4, 380–386.

Wechsler, H., Rigotti, N.A., Gledhill-Hoyt, J., Lee, H., 1988. Increased levels of cigarette use among college students: a cause for national concern. Journal of the American Medical Association 280, 1673–1678.

Wyckham, R.G., 1997. Regulating the marketing of tobacco products and controlling smoking in Canada. Canadian Journal of Administrative Sciences 14, 141–165.

Yen, S.T., Jones, A.M., 1996. Individual cigarette consumption and addiction: a flexible limited dependent variable approach. Health Economics 5, 105–117.